PAGES

MISSING

Volume 25 Toronto, Nov. 20, 1913

Contents of this issue on page 743

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

NOTES ON PROVINCIAL LAND SURVEYING

CALCULATION OF COMPASS-SURVEYED AREAS BY DOUBLE MERIDIONAL DISTANCES—PLOTTING BY THE USE OF CO-ORDINATES—RESPECTS IN WHICH THE PRACTICE OF SURVEYING HAS CHANGED

By J. A. MACDONALD, Ottawa, Ont.

IT is generally conceded among surveyors that there is but one absolutely correct method of calculating the area of a compass-surveyed plot of ground. In compass surveying there is necessarily the intrusion of a number of errors, the number generally depending upon the number of courses. This may be readily explained. Five minutes is the closest reading that any surveyor may expect from the compass, and frequently the variation may be ten or even fifteen minutes. In one mile, therefore, where ten minutes mean twenty-three links, the liability of error becomes comparatively great, considering the fact that errors often occur in reading with a good transit, where there is fine precision, to the extent of thirty seconds, and with levels in good order. With such a liability of error, therefore, one may not expect to tie on the starting point of a compass survey. In plotting, it is found necessary to balance the errors of each course, i.e., to divide them *pro rata* among the courses according to length. This is done most satisfactorily by Double Meridional Distances.

Double Meridional Distances.—In plotting a compass-survey which, by the way, must be done by latitudes and departures, there is a favorable feature in the compass which the transit does not possess, that is noticeable. If there is an error in one deflection angle read from the transit, this error arising from improper levelling of the instrument, or its being set up on marshy or infirm ground, all the following courses are intensified in error, a succeeding course depending on the course just taken as a back-sight. With a compass an error in one course does not necessarily lead to an error in the succeeding courses, every course being independent of the other. In plotting a compass survey, therefore, latitudes and departures must, in nearly all cases, be taken, rather than measurements by deflection angles. This, of course, is the proper method of plotting a transit survey also, but it is not always used on account of the extra labor involved in calculating the latitudes and departures. With a table of latitudes and departures, given to minutes, as are now obtainable, however, it is not a laborious task.

The parallel ruler used to be an indispensable requisite of the old compass surveyor. This is found very convenient in plotting—in fact, it is almost the *sine qua non* of a compass surveyor's instruments. Set squares are now used more generally and particularly for railway work. It might be stated that the method of latitudes and departures is now mostly used in plotting railway plans. But in plotting railway plans the meridian, whether magnetic or astronomical, is not passed through each station as is usually done when plotting a field survey made by a compass, and using the parallel ruler, and the protractor for plotting. These two instruments go hand in hand, one being a complement of the other.

There is another method, and the one mostly used in plotting railway plans by latitudes and departures. This is by the use of the set squares and the scale; no protractor being used. On the National Transcontinental Railway, plotting the traverses and the locations with a protractor was forbidden. The latitudes and departures, sine and cosine, being calculated, the latitude was scaled from the last station, using the set of squares to parallel the meridian on the plan and precisely at right angles with it, the distance measured and marked. From this point, and precisely at right angles, the departure was scaled and marked, and the intersection of these lines indicated the new station. This method, while it would answer with a compass survey, is seldom, if ever, used; at least, it was not used by the old surveyors. The protractor and the parallel ruler were usually the instruments used for plotting, and are, as already stated, the most convenient instruments for plotting surveys made with the compass to-day.

Much more attention was given by the old compass surveyors to plotting and lettering than is given by present-day surveyors. It is interesting to note the beautiful work (now considered altogether unnecessary) of some of the old surveyors, which is to be seen in the land office at Ottawa. There must necessarily have been a good deal of time taken over this work, which one would now be ready to call "lost time," but in those days time was not such an important factor as in these strenuous times, and the mighty rush and competition existing at present does not warrant taking any more time over a plan than is absolutely necessary. There is no time now for artistic work, old English letters and elaborate north prints. Stamps and stencils, and even the typewriter, do considerable of the lettering to-day.

Taking the plot, shown on page 498 of *The Canadian Engineer*, (Fig. 2) the plot, Fig. 1, is how it looks when plotted with the protractor and parallel ruler. It will be seen that the last course does not tie to the starting point, nor will any compass-survey tie unless, perchance, the errors balance. To join the line of the last course with the first will change the bearing of that course, and that would make it different to what it is on the ground, and would vitiate the plan. What must be done, is to balance all the courses, deducting or adding, as the case may be, a little to all of them. This cannot be conveniently or correctly done except by the method of Double Meridional Distances, as explained below.

Table I.

Stations.	Bearing.	Distance.	Latitudes. N.	S.	Departures. E.	W.
1	S. 63° 15′ E.	11.25		5.06	10.04	
2	N. 80° 00′ E.	11.03	1.91		10.86	
3	S. 50° 10′ E.	12.09		7.74	9.28	
4	N. 16° 00′ E.	6.10	5.86		1.68	
5	N. 42° 30′ E.	13.50	9.94		9.11	
6	N. 70° 20′ E.	11.38	3.85		10.71	
7	N. 3° 15′ E.	9.10	9.08		0.59	
8	N. 34° 30′ W.	10.45	8.61			5.91
9	N. 75° 15′ W.	28.45	7.24			27.51
10	S. 32° 30′ W.	38.15		32.17		20.49
Totals		151.50	46.49	44.97	52.27	53.91
			44.97			52.27
		Error in latitude	1.52	Error in depart.		1.64

Referring to Table I., it is prepared as follows: By means of a traverse table, or by sines and cosines, find out the latitude and departure for the angle of each course. By adding up the four columns find the difference between the N. and S. columns and also the E. and W. columns. In this instance there we find that the N.'s are 1.52 greater than the S.'s, and that the W.'s are 1.64 greater than the E.'s, causing a serious closing error as plotted by the protractor. (Fig. 1).

To divide the errors prepare a table precisely the same as the foregoing, except that the horizontal spaces are farther apart, and that the adding up of the old N., S., E. and W. columns are omitted. The additional columns are made subsequently. The new table is as Table II.

We have found by the first table that the N.'s and the W.'s are too long, and therefore must be shortened; while the S.'s and E.'s must be lengthened, all of them in the following proportions,—Sum of all the distances: any given distance:: total error of latitude or departure: error of latitude or departure of given distance.

Thus commencing with the latitude of distance 1, we have, as the sum of all the distances, = 151.50: distance (1) = 11.25:: total latitude error, = 1.52: latitude error of distance (1) = .11.

Now, as the latitude of distance, or side, 1 is south, it must be lengthened, so it becomes = 5.06 + 11 = 5.17, as figured out on the new table.

Table II.

Station.	Bearing.	Distance.	—Latitudes— North. (+)	South. (—)	—Departures— East. (+)	West. (—)	Total latitude.	Total departure.	Double meridional distance.
1	S. 63° 15′ E.	11.25		5.06	10.04				
				.11	.12				
				5.17	10.16		— 5.17	+10.16	10.16
2	N. 80° 00′ E.	11.03	1.91		10.86				
			.11		.12				
			1.80		10.98		— 3.37	+21.14	31.30
3	S. 50° 10′ E.	12.09		7.74	9.28				
				.13	.14				
				7.87	9.42		—11.24	+30.56	51.70
4	N. 16° 00′ E.	6.10	5.86		1.68				
			.05		.07				
			5.81		1.75		— 5.43	+32.31	62.87
5	N. 42° 30′ E.	13.50	9.94		9.11				
			.14		.14				
			9.80		9.25		+ 4.37	+41.56	73.87
6	N. 70° 20′ E.	11.38	3.85		10.71				
			.12		.12				
			3.73		10.83		+ 8.10	+52.39	93.95
7	N. 3° 15′ E.	9.10	9.08		0.59				
			.10		.10				
			8.98		0.69		+17.08	+53.08	105.47
8	N. 34° 30′ W.	10.45	8.61			5.91			
			.11			.11			
			8.50			5.80	+25.58	+47.28	100.36
9	N. 75° 15′ W.	28.45	7.24			27.51			
			.29			.30			
			6.93			27.21	+32.51	+20.07	67.35
10	S. 32° 30′ W.			32.17		20.49			
				.34		.42			
				32.51		20.07	0.00	0.00	20.07

Sum of sides	151.50
Sum of northings	45.55
Sum of southings	45.55
Sum of eastings	53.08
Sum of westings	53.08

Again, we have for the departure of distance 1: Sum of all the distances, 151.50: distance 1, 11.25:: total departure error, 1.64: departure error distance 1, .12.

As the departure of distance 1 is last it must also be lengthened, hence it becomes 10.04 + 12 = 10.16, as figured out on the new or second table.

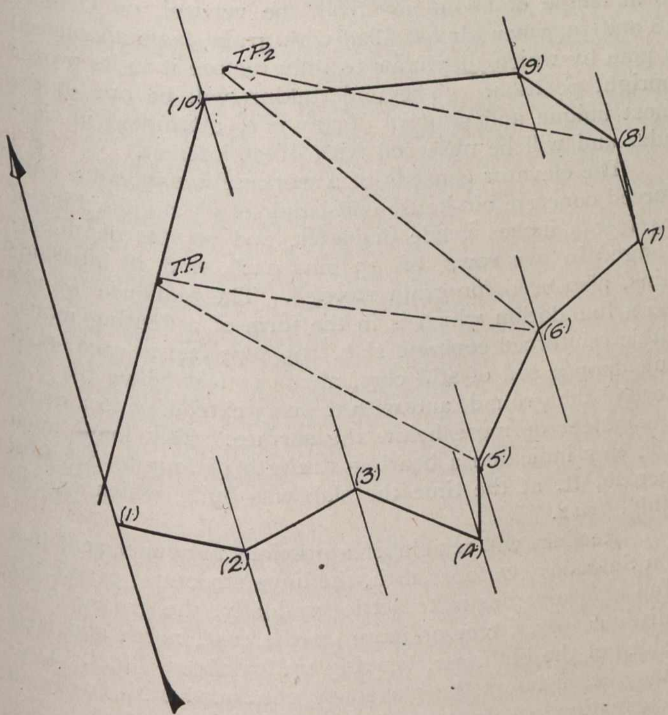


Fig. 1.

Proceeding thus with each side, we obtain all the corrected latitudes and departures shown in the new table. If we now add up the four columns of corrected N. S. E. W. values, we find that the northings equal the southings, and the eastings equal the westings, thus proving that the work is now correct. The corrected latitudes and departures must necessarily change the bearings and distances of every side, but without knowing either of these we can plot the survey by means of the corrected latitudes and departures alone, and without the use of the protector at all. When the closing error is small this is unnecessary, but when the closing error is large, as in this case, in balancing the errors of latitudes and departures, the surveyor usually interprets those errors by inspection, and without taking the trouble of calculating them. By judicious inspection the total errors can be approximately apportioned to each course in both latitude and departure.

Plotting by the Methods of Co-ordinates.—The method of plotting by co-ordinates, i.e., traverses may be performed in two ways: First, the stations shown in Fig. 1 might be laid down from the columns of latitudes and departures, but it would be necessary, in order to plot them, to draw parallel meridians through each station, as shown in Fig. 1, and to lay down each successive station from that which had been plotted before it. As each operation will thus be referred to a new point, in itself dependent on that which preceded it, the sources of error become increased with the number of fresh stations to be plotted. But by referring each station to the meridian of Station 1, both for latitude and departure, as in Fig. 2, any error which may occur in laying down one point is not carried on through the series, the fixing of that point being an isolated operation, independent of every other in the survey. The advantage of such a mode of protection is too apparent to need further comment.

Instead, therefore, of picking off these northings and southings in succession from each other, it is much more proper to prepare the column of total latitudes (column eight) showing how far each of the points, 2, 3, etc., is north or south from Station 1. This being done, the points can be located on Fig. 2, north and south from 1 without moving the scale each time and, of course, with greater accuracy. Such a column is readily formed. Its accuracy is proved by the final result being Zero. A similar column of total departures is prepared (shown in the ninth column of the table) which gives the distances of the points 2, 3, 4, etc., each from the meridian line. Thus, starting from point 1 with side 2, the work likewise proves itself by the final result being Zero.

Starting from the meridian, passing through 1 and the point 1, the first station, mark a point 2′ southward on the meridian, 517 links, and from 2 on a line perpendicular to the meridian, mark a point to the west 1,016 links, which will be station 2, 1—2 representing the amount of southing, and 2′—2 the amount of westing of the point, as referred to the first station 1. Similarly for the others, join stations 1—2, 2—3, etc., which will represent the distance measured, and in the present case the complete lines of the boundary. The details of the survey and the features of the country, offsets, etc., where necessary, are supposed to be put in, as usual, from the field book. The practised surveyor will find the above description sufficient to enable him to plot boundaries or maps, and their lines of road.

In all tables of this kind it is usual to make north and east, plus (+) and south and west minus (—). The use of the symbols save a lot of work. For instance, one column answers instead of two in the table.

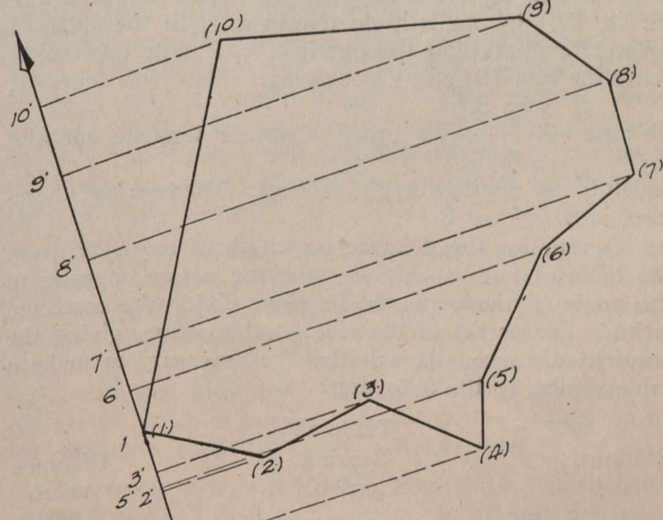


Fig. 2.

Calculating the Area.—The adaptation of the tables to the calculation of areas may be explained as follows: In calculating the area of an enclosure or boundary survey, it is necessary to assume a meridian to which to refer the departures of all stations in the survey. This should in all cases be that of the most westerly station in a boundary survey, as the north differences of latitude become then all positive, and the south all negative multipliers.

Column nine in Table II. contains the departures of each station on the boundary east of the meridian of Station 1, which is stated as the datum, because it is most westerly of the whole survey.

Column ten is introduced solely with a view to facilitating the computation of the areas, by bringing the numbers to be multiplied together into juxtaposition. This column is derived from column eight by simple addition. All operations are performed with such facility that, with the exception of taking out the traverses which occupies a somewhat longer time, the whole table may be filled up in a few minutes.

Table III.

Station	Northings	Southings	Double Meridional Dist.	N. Products	S. Products
1		5.17	10.16		52.527
2	1.80		31.30	56.340	
3		7.87	51.70		406.879
4	5.81		62.87	365.274	
5	9.80		73.87	723.926	
6	3.73		93.95	350.433	
7	8.98		105.47	947.120	
8	8.50		100.36	853.060	
9	6.93		67.35	466.735	
10		32.51	20.07		652.475
				3762.888	1111.881

Subtracting 3762.888 N. from S. products, 1111.881, equals 2651.007, divided by 2 equals 1325.503 square chains, equals 132.55 acres, plus offsets.

It now remains only to calculate the corrected bearings and distances, or length of the sides of the survey, all of which are necessarily changed by the adoption of the corrected latitudes and departures. This operation will only be necessary where the changes are large. To find the bearing from any station, divide its departure (E. or W.) by its latitude (N. or S.); in the table of natural tangents find the quotient, the angle opposite it being the required angle of bearing. Thus, for Course 1,

we have $\frac{5.17 \text{ S.}}{10.16 \text{ E.}} = .5088$ = natural tangent, opposite which is the required angle, $63^\circ\ 02'$. The bearing, therefore, is S. $63^\circ\ 02'$ E.

Again, for the distance or length of any side, from the table of natural cosines take the cosine opposite to the angle of the corrected bearing, divide the corrected latitude (N. or S.) of the side by the cosine, giving the required distance. It will then be necessary to make a table similar to the following:

Table IV.

Stations.	Bearing.	Distance.
1	S. $63^\circ\ 02'$ E.	11.40
2, etc., etc.	....	.....

This table will contain all the corrections of the foregoing survey, and if the bearings and distances are correctly plotted, they will close perfectly.

Postmaster-General Samuel, of London, Eng., is inviting applications on tender for the construction of the second of three high-power wireless stations to form an Imperial chain from contractors able to satisfy experts by a practical demonstration of the efficiency of their system. The demonstrations will be required to indicate the capacity of the respective systems to carry on continuous and efficient communication, day and night, over a distance of 2,000 miles.

RESTORING THE TRANSCONA ELEVATOR.

THE contracting firm of Barnet-McQueen Company, Limited, of Minneapolis, who designed and constructed, last year, the 1,000,000-bushel grain elevator for the Canadian Pacific Railway at Transcona, Man., which structure sank and listed to an angle of about 30° from the vertical, on October 18 and 19, when almost filled with grain, have announced a plan by which they hope to fully restore it to its proper upright position. The undertaking will be one of the most unique and unusual of any ever attempted in Canada, and will be observed with great interest.

The elevator consists of a working-house and a reinforced concrete bin-house consisting of 65 circular bins of 14 feet 4 inches inside diameter, and 90 feet depth, arranged in five rows of 13 bins each, and 48 interstice bins, also used for grain storage. The binhouse is built on a foundation which is in the form of a floating monolithic reinforced concrete slab, 195 x 77 feet in area, resting upon a soil of stiff clay, about 12 feet below the surface of the ground, and with the clay extending to a depth of 45 feet or more below the surface. Test loads upon the clay indicated a bearing strength of four to five tons per sq. ft. at the time the slab was built, which was in July, 1912.

Readers will remember a previous announcement that on Saturday, October 18th, the huge structure, practically full of grain, began to settle gradually, the ground for a distance of 25 feet or more on the east, north and west sides of the binhouse, heaving up for about 6 feet. During the 24 hours the movement continued until finally an inclination of about 30°, as stated, was reached. The foundation line of the eastern portion then rested about five feet above its proper level, while the opposite side sunk in the neighborhood of 30 feet. While the listing was in progress, the roof structure and the conveyer cupola slid off and were demolished. The removal of this portion of the load apparently checked the movement of the foundation.

It is interesting to note that the structure itself is but little damaged. The bins, containing practically 1,000,000 bushels at the time, remained intact, and it is just announced that practically all of the wheat consigned for lake shipment before the close of navigation, has been removed without loss through waste or fermentation due to the possible intrusion of ground water. This has been accomplished by tapping the bins through the sides, and erecting temporary conveyers between the bins and the railway cars. The removal progressed at the rate of about 40 carloads per day.

Mr. J. G. Sullivan, chief engineer of the Canadian Pacific Railway, at Winnipeg, has expressed himself of the opinion that neither the design nor construction of the building have been at fault in any way, and that the unfortunate occurrence, due to the crushing out of the foundation sub-soil, was ultimately caused by the shifty material below the 30 to 40 feet of clay with which Winnipeg and its vicinity are underlaid. This material makes it almost impossible to go down below the clay even by sinking air caissons. Practically all foundations in the vicinity of Winnipeg are therefore of the floating type, and heavy structures have frequently been known to settle as much as a few inches. In the case of grain elevators, unusual care is always taken to have the grain distributed as evenly as possible to prevent eccentric loading.

Concerning the restoration of the elevator, the contractors are planning to excavate below the eastern portion, allowing it to sink and become perpendicular.

Powerful jacks will then be used to support the structure while the strengthening of the foundation is in progress. When this is completed the elevator will be allowed to rest upon the new surface, and repairs, including the steel roof structure and cupola, will then be made. It is estimated that it will cost approximately $30,000 to restore the structure.

MANITOBA'S LOG-DRAG COMPETITION.

THIS year the first, second and third prizes for gravel roads in the log-drag competition which was inaugurated four years ago under the auspices of the Manitoba Good Roads Association, went to the municipalities of Rockwood, Kildonan, and St. Paul, respectively. In the case of earth roads, they were awarded to Macdonald, Springfield, and Macdonald, in the order named. The winners received their awards at a banquet given by the association on October 29th, in Winnipeg, Mayor Deacon officiating at the presentation. The judges in the competition, who had presented their decision at a previous meeting, were Mr. C. F. Tallman, Street Commissioner of Winnipeg; Mr. A. McGillivray, Manitoba Highway Commissioner, and ex-Mayor Waugh of Winnipeg.

In the course of his remarks, the mayor suggested that it would be well for the municipalities to seriously consider the use of asphalt or concrete as a road material, and expressed his belief that their use would be better throughout the province than the building of any amount of clay roads with gravel surface. He also suggested that it might be more advisable to consider the abandoning of fixed survey lines in construction of new roads, with a view to carrying the roads along better locations, exchanging the road allowances with the land owners.

Hon. Dr. Montague, Minister of Public Works for Manitoba, in speaking of the good roads movement, referred with pride to the streets of Winnipeg, and declared that no city in eastern Canada or in the United States had made the progress in the matter of good streets that Winnipeg has made. He expressed his opinion that the subject of roads in Manitoba was almost entirely an agricultural problem, rather than a motor problem, and was of more importance than nine out of every ten agricultural questions under discussion to-day. It was the problem of bringing the farmer in closer touch with shipping facilities for his products.

Dr. Montague referred to the city of Winnipeg voting $13,000,000 for a new water supply, and $6,000,000 for the installation of a power plant, and intimated that a yearly grant from the Dominion Government of $25,000,000 for the construction of good roads throughout the country would be most timely.

Over 110 members of the association and farmers from surrounding municipalities were present at the banquet, presided over by Reeve Henderson, of Kildonan, president of the association.

At its meeting on October 3rd, the association drew up and sent on a resolution to the Union of Manitoba Municipalities, convening this month at Portage la Prairie,, requesting that the government take over the construction of all the leading highways in the province; that it levy a special tax of one mill on the dollar in the total assessment value of the province, and that the cost of construction be covered by a payment of one-half of the cost of the road from the fund so raised, the government to pay an additional 25 per cent. and the benefited property the remaining 25 per cent.

THE ADOPTION OF FUEL OIL.

THE rapidity with which fuel oil has been displacing coal in many lines of industry has become a point worthy of note the world over. Thirteen years ago oil as a competing fuel with coal was practically unheard of on this continent. The first experiment along the lines on which it has now become so important was the conversion in 1900 by the Southern Pacific Railway of one of their locomotives from the use of coal to oil. That was the beginning. At the present time oil-burning locomotives are operated exclusively upon 20,910 miles of line in the United States, and 587 miles in Canada; and, in conjunction with coal burners, on an additional 4,720 miles in the United States. Some idea of the enormous rapidity of the adoption of oil may be formulated when it is considered that a length of track capable of encircling the globe has been converted from the use of the one fuel to the other in such a short period of time.

The two chief sources at present are the vast fields in Texas and in southern California, as is well known. From the accompanying map it is seen that considerable development has taken place in Texas with lines reaching some distance northward, also in a westerly direction to Southern California. From Southern California the advance has been most pronounced, owing to the facility of water transportation along the coast, and to the expensive variety and unsatisfactory quality of the coal in the Western States.

In a recent article by H. Foster Bain on "Fuel Problems on the Pacific" the following facts were noted: Fuel oil is delivered from Alaska to Peru at prices giving it marked advantage over coal, not taking into consideration the incidental advantages of cleanliness, lower cost of handling, and decreased fire room expenses. Fuel oil is delivered on the Coast at 85 cents to $1 per bbl., equivalent to a cost of $3 to $3.50 per ton for coal, considering fuel value above 3 to 3½ bbls. corresponding in heating value to a ton of coal. The surplus above ground, over 40,000,000 bbls., the extent of territory developed, and the ease with which production is increased, give every assurance of continued supply at a reasonable price for years to come.

The use of oil for locomotive purposes is purely an economic question, depending on the relative cost of oil, coal, and electricity, except perhaps when oil is enforced by law owing to the necessity for fire protection. On the Pacific Coast practically all railway companies, and some who even own their own coal mines, have adopted oil, the use of which is almost as rapidly being taken up at sea, where its use is even more advantageous.

The general points favoring use of oil fuel in locomotives are:—

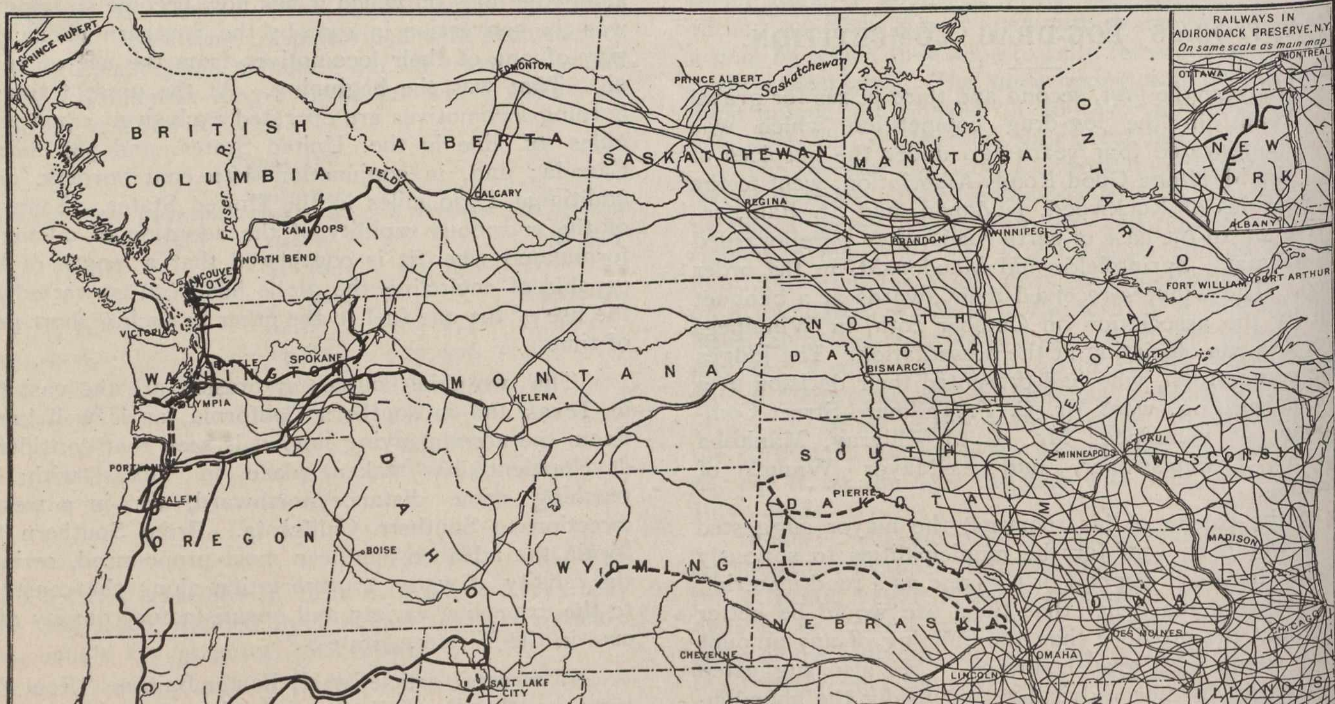
(1) Saving in time and labor in loading.
(2) Reduction of staff for handling.
(3) Increased cleanliness.
(4) More complete combustion and therefore greater efficiency.

To these may be added, in the case of marine use, a fifth and a sixth advantage—the saving of considerable room in the hold, and the reduction of boiler repairs. The latter would also seem to apply to locomotives, but from the report of A. E. Hudson, inspector for the Canadian Board of Railway Commissioners on the C.P.R. engines in British Columbia using fuel oil, we are lead to believe that such is not the case. According to Mr. Hudson, since the conversion of these locomotives "a great many leaks have developed in the boilers, such as the crown bolts, and side sheets leaking badly."

It might here be interesting to note, in conjunction with the adoption of oil at sea, the comparative costs of coal and oil on the C.P.R. British Columbia Coast service steamship "Princess Victoria."*

Coal—	Per day.
100 tons @ $4.50	$450.00
9 firemen @ $55 a month	16.50
9 trimmers @ $45	13.50
Food for 18 men	7.56
	$487.56

Oil—	Per day.
344.17 barrels @ 90c.	$314.25
6 firemen	11.10
Food for 6 men	2.53
	$327.87



OIL AND COAL-BURNING RAILWAYS IN CANADA AND UNITED STATES

This comparison, together with the above remarks relative to the cost of oil, only applies to the Western States and British Columbia. The conditions in the east are entirely different. The distance from the oil fields and presence of coal in large quantities makes the latter the predominant fuel. The contrast between east and west is clearly shown by the map already referred to. Nowhere is oil used east of the Missouri and Mississippi Rivers, except in the Adirondack Preserve, where its use is enforced by law for fire protection. Relative to the cost of oil in the east, C. S. Sims, second vice-president

*From report of G. W. Dickie, published in "The Vancouver Province."

and general manager of the Delaware and Hudson Company, states that in 1910 oil for the locomotives of that company, working in the Adirondacks cost $57,260.33 at 2.25c. per gallon, or 28.33c. per engine mile, or $36,045.88 in excess of the cost of doing the work with coal. The cost per engine mile for coal during the same period was 10.46c. For 1912, oil cost $83,703.31, or an increased cost over coal of $56,454.96. For three years, 1910-12, the increased cost of using oil has been $119,077.09. He then states that for a much lower price a wonderfully effective patrol system could be installed. And this seems to be the consensus of opinion in the east, where oil is proposed for fire protection, though it is not disputed that the adoption of oil is much better than the best system of patrol. With the best possible safeguards applied to coal-burning locomotives, it is impossible to prevent sparks being thrown from the stack, whereas with oil there can be no danger except from a little red-hot carbon from the stack; and this can be avoided if the engineer is careful to introduce the "sand seam" at a place where fire would be impossible.

There seems to be no doubt that as a means for preventing the all too frequent forest fires oil fuel far surpasses coal. The question is, should the railways be forced to bear the whole additional cost? Several logging companies operating their own lines have adopted oil, finding that in the long run the advantage is tremendous, owing to reduction of fire loss alone. They are also using oil for donkey engines, and with the increased boiler efficiency have been able to greatly increase their output.

On the other hand, it is noteworthy that, owing to the increased price of oil fuel in the last few years, some companies have been forced to abandon it for coal, chiefly on some of their more easterly lines. Portions of the Rock Island, Sante Fe and 'Frisco roads have recently replaced some three thousand miles with coal burners. Abroad, also, the Australian government lines are abandoning oil because of its enhanced price, whereas at the same time another announcement demonstrating the progressive side of the movement is to the effect that "oil-burning locomotives are being considered for some of the government railways in India."

In conclusion, and extract from the report† of the Commission of Conservation shows the situation in Canada:

"In Canada, the Great Northern Railway is the pioneer among passenger lines. This line is using oil exclusively on its 115 miles of railway in the Cascade Division. This embraces all lines in the vicinity of the Pacific Coast.

"During 1912, the Canadian Pacific Railway established oil burners on its main line between Kamloops and Field, B.C., and on the Arrow and Okanagan branches, making a total of 338 miles. It is now announced that, during 1913, this line will extend the use of oil burners to cover the main line between North Bend and Vancouver, 129 miles, and the Mission subdivision, 10 miles. When this work is finished, the only portion of the main line of the C.P.R. in British Columbia not using oil fuel will be the portion between the eastern boundary of the province (Hector) and Field, 12 miles, and between Kamloops and North Bend, including the Nicola branch, 168 miles; total, 180 miles. The oil-burning portion of the line in British Columbia will then comprise 477 miles."

†Commission of Conservation, Canada, "Forest Protection in Canada," by Clyde Leavitt, M.Sc.F., 1913.

For those requiring more information on this subject than is contained herein, the report of the Commission of Conservation just issued (and upon which the above is largely based) will be of especial value. With this report in mind and several other articles which have been appearing in the scientific press from time to time during the past few years, a world-wide adoption of fuel oil at sea can safely be predicted, and on land in those vast areas over which fuel oil may be more readily obtained than coal. A very interesting point in connection with the fuel problem the world over is that coal is a far too valuable substance for consumption as in vogue at present, and that perhaps before long a new method of coal consumption may be introduced.

BRICK FOR COUNTRY ROADS.

In Bulletin 23 of the U.S. Department of Agriculture, a treatise is presented on the construction and maintenance of brick pavements, with especial reference to their use on country highways. The authors are Vernon M. Pierce and Chas. H. Moorefield, chief engineer and senior highway engineer respectively of the Office of Public Roads. A brief sketch is given of the development of brick paving, followed by a description of the materials used for paving bricks, and their manufacture. The physical characteristics of these materials, and the methods in vogue for testing them are included. For a concise and authoritative treatment of the subject, readers are referred to this bulletin. We reproduce herewith some information contained in it, respecting the preparation, construction and cost of brick paving in rural districts.

The principal advantages which brick roads possess may be stated briefly as follows: (1) They are durable under heavy traffic conditions; (2) they afford easy traction and good foothold for horses; (3) they are easily maintained and kept clean; and (4) they present a pleasing appearance.

The principal disadvantage is the high first cost. The defects which frequently result from lack of uniformity in the quality of the brick or from poor construction are usually to be traced indirectly to an effort to reduce the first cost or to a popular feeling that local materials should be used, even when inferior.

In the preparation of the subgrade upon which a brick pavement is to be constructed, the essential features to be considered are thorough drainage, firmness, uniformity in grade and cross section and adequate shoulders.

Strong durable curbing should be supplied both on the sides and at the ends. Otherwise, the marginal brick will soon become displaced by the action of traffic and deterioration will spread over the entire pavement.

Satisfactory curbing may be constructed of stone, Portland cement concrete, or vitrified clay shapes made especially for this purpose. With stone the individual blocks should be not less than about 4 feet long and should have a depth of about 18 to 36 inches, depending on traffic conditions and on whether the curb is to project above the surface to form one side of the gutter. A thickness of 4 inches will ordinarily prove satisfactory. Stone curb should always be set on a firm bed of gravel, slag or broken stone, not less than 3 inches thick, and should be provided with a backing of the same material on the shoulder or sidewalk side.

Concrete curbs may be constructed alone or in combination with either a concrete gutter or a concrete foundation. The advisability of constructing the curb in combination with the foundation, however, is doubtful. Concrete curbs should have approximately the same cross-sectional dimensions as stone curbs and should be constructed in sections not exceeding about 7 or 8 feet in length.

Vitrified clay curbing should be set in much the same manner as that described for stone curbing. The principal additional requirement is that, since vitrified clay is a lighter material than stone and the curb sections are ordinarily shorter, the bedding must be made correspondingly more secure in order to prevent displacement.

The proper type of foundation depends largely on the material composing the subgrade and the character of traffic for which the road is designed. Where the traffic is comparatively light and the subgrade is composed of some firm material which does not readily absorb water, a very satisfactory foundation may be constructed of broken stone or gravel filled with sand. Where the traffic is comparatively heavy, however, or where the material composing the subgrade is defective in any way, a monolithic concrete foundation should be used.

Gravel and broken-stone foundation may be spread in one or more courses, each of which should be from 5 to 9 inches thick before compacting. The stone or gravel should be clean, hard, tough and durable and should be graded in size between certain reasonable, fixed limits. It should be compacted in the usual manner by rolling with a power roller weighing not less than about 10 tons, and sufficient clean, course sand to fill the voids should be spread and flushed into the foundation while the rolling is in progress. When complete the foundation should present a surface uniform in grade and cross section and parallel to the proposed surface of the finished pavement.

Concrete foundations are unquestionably better adapted for brick pavements than any other type. They are practically monolithic in form, nearly impervious to water, and possess a relatively high crushing strength. All of these qualities may be obtained with a relatively "lean" concrete if the subgrade has been properly prepared. Under ordinary circumstances a satisfactory foundation may be constructed of concrete composed of 1 part of Portland cement, 3 parts of sand, and from 5 to 7 parts of broken stone or screened gravel.

It is necessary to provide an adjustable cushion of some kind between the foundation and the brick for correcting any slight irregularities in the surface and to secure an even bearing for the brick. Sand has been found a most satisfactory material and is almost exclusively used. The proper thickness for this sand cushion will of course depend on the extent of the inequalities. Two inches has generally proved very satisfactory.

After the cushion is spread uniformly it should be thoroughly compacted by rolling with a hand roller weighing from 300 to 400 pounds, and any depressions which form should be corrected.

The brick may all be hauled and piled at convenient intervals along the sides of the roadway before grading is begun. Hauling over the finished pavement with wagons until it is complete and opened for traffic should be avoided. If the brick are delivered on the work as needed, they should be unloaded from wagons outside of the curb and carried to the pavers, either by hand or in wheelbarrows. Plank trackways should also be provided over the newly laid pavement for the wheelbarrows when they are used.

The brick should be laid on edge and in uniform courses running at right angles to the line of the pavement, except at intersections; and in order to "break the joints" each alternate course should begin with half a brick. In laying the brick the pavers stand on the pavement already laid and, beginning at the curb each time, carry across as many courses together as they can conveniently reach. The courses should be kept straight and close together, and if necessary each block of eight or ten courses should be driven back by means of a sledge and a piece of straight timber approximately 2 by 4 inches by 5 or 6 feet long. The brick should also be laid close in the courses and should be crowded together, if necessary, after a course is laid, by means of a crowbar inserted at the curb.

After the pavement has been laid and all defective brick have been replaced to the satisfaction of the engineer, the next step is to sweep the surface clean and smooth out all inequalities by means of ramming or rolling. The rolling should be done with a power roller weighing from 3 to 5 tons, and the pavement should ordinarily be rolled in both the longitudinal and transverse directions. The longitudinal rolling should be done first and should begin at the curbs and progress toward the crown. The roller should pass at least twice over every part of the pavement in both directions.

In order to keep the brick in proper position and protect the edges from chipping, it is necessary to fill the joints with some suitable material before the road is opened to traffic. The materials which have in the past been most commonly used for this purpose are sand, various bituminous preparations, and a grout made of equal parts of Portland cement and fine sand mixed with water.

Sand is the least expensive of these materials, but there are several very serious objections to its use as a joint filler. Bituminous fillers vary considerably in quality and efficiency, but all are more or less unsatisfactory. One of the principal objections to their use is based on their tendency to run out of the joints into the gutters during warm weather and to crack and spall out during cold weather. This tendency can, of course, be partially overcome by exercising proper care in selecting the materials. It should also be noted in their favor that brick pavements, the joints of which have been filled with bituminous preparations, are ordinarily less noisy at first than those in which a Portland cement grout filler has been used. The grout filler is unquestionably very much superior from a standpoint of durability, however, and the excessive noise under traffic which has been frequently observed in connection with its use can be largely eliminated by the use of proper bituminous expansion cushions along the curbs. It is, therefore, recommended as better adapted for filling the joints in brick pavements than any other material which has been commonly used for that purpose.

Expansion cushions should be provided for at the time the brick are laid, by placing a board of the required thickness on edge adjacent to each curb. Small iron wedges may be inserted between the curb and the board at the time the board is set. These wedges may be readily loosened and removed after the bricks have been laid and grouted, and may consequently be made to facilitate the removal of the board.

The proper thickness for expansion cushions is a matter concerning which much difference of opinion exists among highway engineers. Some engineers advocate a minimum thickness of 1 inch, while others claim to have secured their best results by using expansion cushions having a minimum thickness as low as three-eighths inch for very narrow pavements.

The cost of brick pavements varies widely, and is affected by so many influences that it is difficult to attempt to derive a general expression showing the relation between probable cost and local conditions. The prices of brick, as also the prices of the various materials entering into the foundation, vary greatly according to the locality and the freight rate. The cost and efficiency of labor is also far from being constant. Furthermore, the material composing the subgrade and the method of preparing it may exert a marked influence on the cost of the pavement.

If C = cost of cement per barrel, S = cost of sand per cubic yard, A = cost of coarse aggregate per cubic yard, B = cost of paving brick per 1,000, and L = cost of labor per hour, with all materials considered delivered on the work and all costs expressed in cents, then the probable cost of constructing a brick pavement, including the subgrade, a 6-inch concrete foundation, and suitable curbs, may be estimated by substituting in the formula:

Cost per square yard $= 1.90\,L + .213\,C + .138\,S + .157\,A + .045\,B$.

The cost as estimated from this formula should, however, be increased by about 10 per cent. to allow for wear on tools and machinery and to guard against unforeseen contingencies. If it is desired to use a different thickness of foundation, it is safe to assume that each inch subtracted or added to the thickness of the foundation will make a corresponding difference of from 8 to 12 cents in the cost per square yard.

PANAMA RAILROAD CROSS-TIES.

SOME interesting data, showing the superior durability of the black guayacum ties used in early days, has been furnished by the chief engineer of the Panama Railroad in his report on the use and life of the hardwood ties laid in the roadbed of the Panama Railroad since 1878. He shows that, according to the annual reports since that date, the greater part of the small hardwood ties used in the original track of the Panama roadbed, as it existed in 1885, were procured from the north coast of Colombia, and were of the variety of wood commonly known as lignum vitae (guayacum recina), now called black guayacum, as distinguished from yellow guayacum, a wood possessing less power of resistance to mechanical wear or decay. Other varieties of wood, such as balsams (or quira), and polvillo, were used in ties, but, practically speaking, the black guayacum is the only variety that has stood the test of time. A few balsam cross-ties, laid in 1900, were taken from the roadbed last year and replaced by larger ties.

All the ties used by the old company on the original track were small, those of black guayacum being "pole" ties, about five to six inches thick, with a 6 to 7-inch face, and 8 feet in length. But, when American Canal operations commenced, these had to be replaced by ties of larger dimensions. However, on a section of the railroad between Empire and Culebra, where the traffic was comparatively light, the small ties were left in the track; and there many of the old small-sized black guayacum ties are still to be found.

When the main line of the roadbed was first double-tracked from White House (near Las Cascades) to Tabernilla, to provide for the movement of spoil trains to and from the Tabernilla dumps, many of the small hardwood ties were removed from this section of roadbed on account of the increased traffic; and, generally speaking, these were found to be in very good condition, showing little, if any, signs of decay—though often badly worn at the rail seat by the mechanical action of the base of the rail, no tie plates being used on the ties, and though frequently "spike killed," caused by the replacing of spikes and changing of rails. However, many of these, and also ties removed after this date, are being re-laid now on the tracks connecting with the new terminal docks at Christobal, a fact which shows that the timber in the ties is practically as good as ever. In the yard tracks, where the smaller size is not objectionable, they are still expected to render a long life of service.

The mechanical wear of the old ties in contradistinction to the decay of the wood is demonstrated by the fact that while the base of the rail, and the driven spikes have cut into the hardwood and weathered it, the material in the balance is as good as ever. The records of the United States have long shown the same experience; but there the ties have probably been used only for 8 or 10 years, whereas local hardwood ties have served for from 20 to 25 years in a tropical climate where all other woods decay in from 3 to 5 years.

Black guayacum is now so valuable for purposes in connection with machinery and manufacturing arts that, for use as cross-ties, it is probably a thing of the past. Both the prices and specifications for guayacum ties show a steady variation throughout the past few years. In the first instance, there has been increase in cost, and in the second, decrease in quality. The regulations state now that the material used shall be black or yellow guayacum, but are more stringent in requirements concerning the hewing and the culling of these, and concerning conformity to a specified table of dimensions. On the other hand, prices have increased 50 per cent. from the year 1898 to the year 1911, though some of this percentage must be discounted to allow for the increase also in the size of the ties. In 1898, first-class ties, 6 x 8 inches by 8 feet, were purchased at $1.50 each; second-class ties, 5½ x 6 inches by 7.9 feet, at $1 each. In 1911, first-class ties 7 x 9 by 8.6 feet, were bought at a cost of $2.25 each, and second-class, 6½ x 8 inches by 8.3 feet, at a cost of $1.75 each.

On good authority it may be stated that substantial progress has been made of late with the scheme which aims at establishing an express service between Great Britain and Australasia, via Canada. The company, which was formed three years ago to carry it out, and in which several well-known British shipowning and shipbuilding firms are interested, is treating with a Canadian syndicate for the purchase of about 400,000 acres of land at Cape St. Charles, on the south-east coast of Labrador, an ice-free port 1,680 miles from Liverpool, or a little more than half the distance between the Mersey and New York. From Cape St. Charles it is proposed to construct a transcontinental railway to the Pacific coast, and if the project materializes, it is claimed that the journey from London to Winnipeg will be performed in five days—giving only two nights at sea—with an additional sixteen days to Sydney, N.S.W., and a corresponding acceleration to many centres in the west of Canada and the United States. The projected highway, with its transpacific extensions to Hongkong and other British possessions in Far Eastern waters, is planned to serve the purposes of war as well as the pursuits of peace.

SKIP-HOISTS.

By Reginald Trautschold, M.E.,
Consulting Engineer, New York City.

THE conveying and elevating machinery so far discussed has all been of the continuous type—that is, apparatus particularly adapted for the purpose of handling material in a continuous stream and thereby realizing large capacity with minimum expenditure of power and time—but there is an equally large class of conveying machinery that performs its operations of handling materials only intermittently or in a succession of cycles; i.e., a cycle of productive work and then one in which the apparatus rearranges itself for the next cycle of productive operation. Particularly is this arrangement carried out in the case of elevating machinery in which single buckets are loaded, raised and then unloaded in some other plane, or where the loaded bucket is raised and carried over a more or less horizontal plane to the discharging point and there emptied, after which operations it is returned to the loading point for more material. This intermittent type of apparatus includes steam shovels, locomotive cranes, traveling bridges of various descriptions, cable-ways, hoisting towers and numerous combinations and modifications of such apparatus; all of which may have a varying loading point, various points or locations at which discharge of load may take place and a more or less varying path over which the loaded bucket may travel between loading and discharging. Such apparatus may be used either independently or in combination with any of the various types of conveying and elevating apparatus described in this series of articles. When used in combination with such equipment, storage hoppers or similar devices are necessary, from which the intermittently operated apparatus may take or discharge its load—occasionally hoppers are used for both operations. Such hoppers simply serve to convert an intermittent to a continuous supply, or vice versâ, and as a temporary storage from which the conveying system can conveniently obtain its load or to which the loaded apparatus can economically and efficiently discharge. The continuous type of conveying and elevating machinery discharges to such temporary storage hopper in a continuous stream and other continuous or intermittent handling equipment can take its capacity therefrom so long as the supply to the hopper is adequate. Hoppers supplied from intermittent apparatus can similarly be used to supply load for other intermittent equipment or to load continuous conveying and elevating machinery, as the discharge from the hopper may be proportioned so that the latter type of apparatus can take only its capacity and will automatically take such amount so long as the supply to the hopper is sufficient.

Another class of conveying and elevating machinery of the intermittent type travels along fixed paths, although in some types of such equipment the loading and discharging points are not necessarily fixed. Common examples of such apparatus are car-hauls, skip-hoists, etc., etc. In many installations such equipment is of even greater economic value than continuous handling apparatus; and, although it is impossible to present formulæ for ascertaining even the probable economic value of such equipment, expressed in terms of net operating cost (each and every installation presenting a distinct and individual problem that must be solved independently) or even to derive equations for approximating the cost of equipment, the importance of this class of machinery is such that a short description of certain types is necessary in forming a comprehensive opinion of the respective value of various mechanical material handling equipments.

When materials are being handled that by their weight, chemical properties, etc., may be excessively destructive to a succession of necessarily comparatively inexpensive buckets, or when the supply of material is of necessity quite intermittent, one of the most satisfactory equipments is the skip-hoist, which primarily consists simply of a skip, or bucket, that is loaded, carried to the discharging point, dumped and then returned to the starting point for another load. As ordinarily employed, skip-hoists are installed for elevating operations only, the skips running either on vertical or slightly inclined tracks, although special forms of skips can be constructed that will permit travel in a more or less horizontal path. The skips themselves may be of almost any conceivable shape or size, depending largely upon the nature of the material to be handled and the capacity desired, and may be run at almost any speed up to 600 feet per minute, and occasionally at even greater speed. They are customarily equipped with bails by which they are hoisted and which are attached to the skips below and to one side of their centre of gravity so that they automatically tip and unload on reaching the discharge point, the tracks here being so located as to allow such position of skip. The skips usually run on four wheels and various systems are employed for compelling the skip to follow the proper tracks when discharging. One very satisfactory arrangement, that employed in the installation illustrated, is to run double tracks the full length of the skip travel, the inner tracks being curved off over the receiving hopper or discharge chute as the skip approaches the end of its upward travel. In such construction, the bail is attached to the skip so that the lower pair of wheels press against and run on the outer set of tracks, while the upper set of wheels, those nearer the open end of the skip, press against and run on the inner set of tracks—those curving out toward the discharge point. With this arrangement, the wheels do not leave their respective tracks, so that when the discharge takes place the skip is upset while the flanges of the wheels, nevertheless, maintain the skip in its proper vertical plane. In installations where the track of the skip is appreciably inclined to the vertical the outer set of track is dispensed with, except for a section at the top of the hoist where the tension on the skip bail would tend to pull the skip from its tracks but for the restraining action of this outer guide. Various other arrangements of tracks are occasionally resorted to, but the object in all cases is to so guide the skip that a continuance of pull on the hoisting cable tends to upset the skip and discharge its load.

Customarily, skip-hoists are either of the balanced type or, if but one skip is used, a counterweight is employed to compensate for the weight of the skip itself. A balanced skip-hoist is simply an arrangement of two skips that rise and fall alternately so that the constant dead weight of one skip balances the other and the power required for operation is simply that necessary to raise the load and the varying unbalanced weight of the cables as the skips or skip and counterweight rise and fall. The maximum weight of the unbalanced cables is comparatively small, as steel cables—necessarily of relatively small diameter and correspondingly little weight—are nearly invariably employed, so that for all practical purposes the power requirements of a skip-hoist is simply the amount necessary to raise its maximum load in the given time, to which must be added a sufficient amount to care for the friction losses, etc. These losses are usually figured as fifty per cent. of the power theoretically necessary for handling the load. Formulæ XXV. and XXV.-a are equations ordinarily employed in figuring the power requirements for skip-hoists and, though apt to give somewhat larger results than necessary, if the installation be carefully designed and erected, are conservatively correct and advisably employed.

Horsepower:

$$HP = \frac{15\ WH}{10000} \qquad \text{Formula XXV.}$$

$$HP = \frac{45\ Qw'VH}{1000000\ (2H + V)} \qquad \text{Formula XXV.-a}$$

Where:—

W = Weight of load handled in tons per hour.
H = Height of hoist (distance that skip travels) in feet.
Q = Capacity of skip in cubic feet.
V = Velocity (speed) of skip in feet per minute.
w' = Weight of material handled in pounds per cubic foot.

Though the great variety of skips that are employed and the numerous conditions that must be met in even a simple installation of skip-hoists make it impossible to derive a formula for ascertaining the cost of equipment, such cost is, nevertheless, very easily arrived at, knowing the conditions of the installation, for the cost of any type of skip is easily estimated, the cost of cables per foot even more easily arrived at, when the weight of the fully loaded skip and also the speed at which it is to be operated are known. Similarly the cost of the necessary hoist, counterweight, sheaves, etc., can be arrived at and, knowing the probable initial cost of the equipment, it requires but simple calculation to obtain the probable net operating cost of the system. Depreciation, renewals and repairs seldom exceed 15 per cent. per year of the initial cost.

The true economic value of the skip-hoist is not based so much on the net cost of its operation, however, but rather upon its convenience and its ability to solve many difficult elevating problems. For instance, in the handling of pig iron and similar heavy materials the skip-hoist often proves an exceedingly efficient and economical system to install, particularly as were such material elevated by an ordinary bucket elevator the wear and tear on the elevator buckets would be very excessive, to say nothing of probable breakage which might be so great as seriously to cripple the system. In the handling of brittle and easily broken materials, such as coke, the skip-hoist also finds extensive use, for if care is taken in the loading of the skips and they are not too roughly and suddenly unloaded, much breakage that cannot be properly guarded against in a bucket elevator is avoided.

Special skips can be constructed of materials that will resist high temperatures, the action of acid or alkali fumes, and other destructive characteristics of certain materials—whether they be liquid or solid—so that the skip-hoist not only ranks in economic value with any

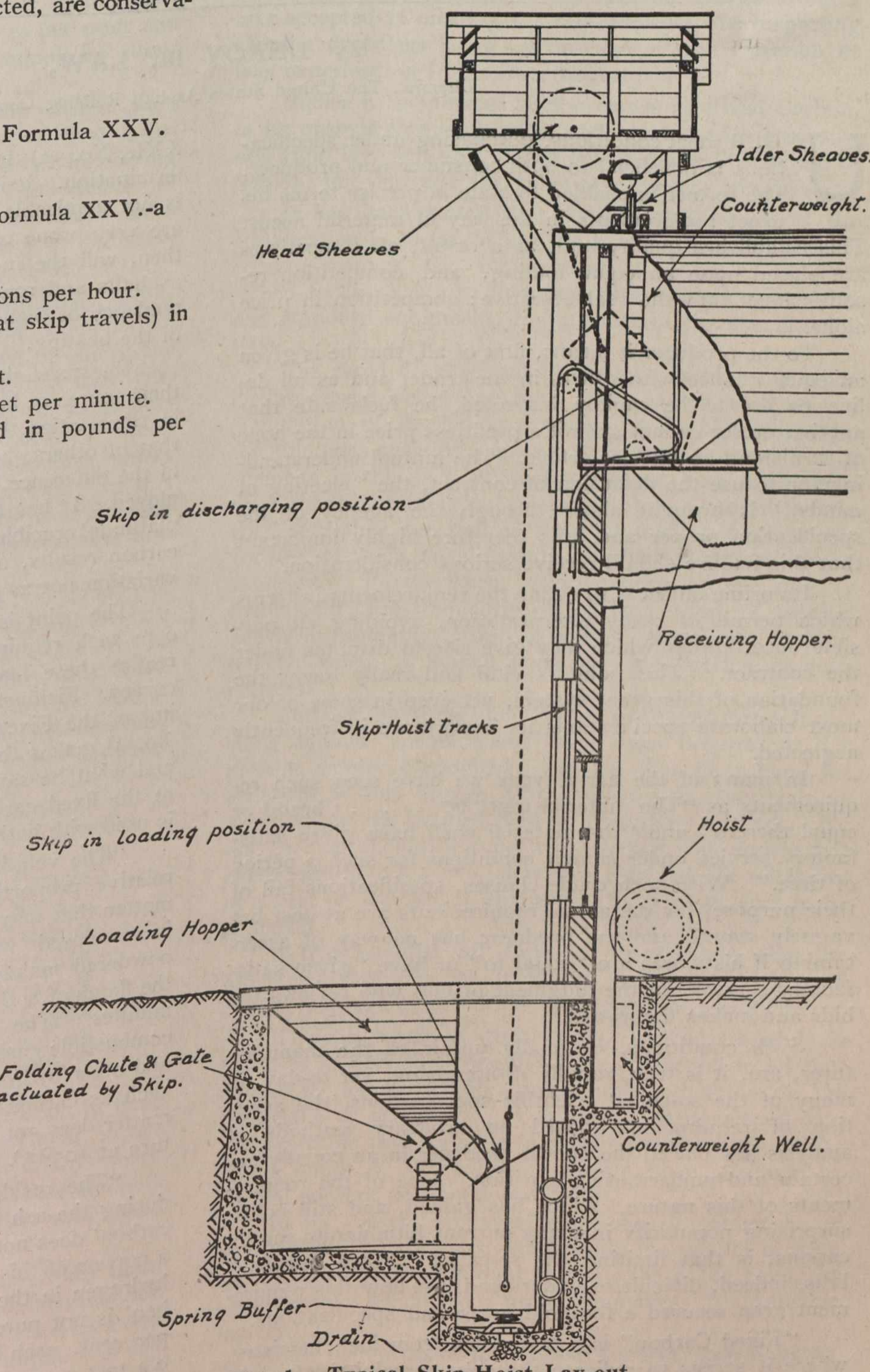


Fig. 1.—Typical Skip-Hoist Lay-out.

other type of conveying or elevating machinery, but very frequently is the desirable equipment to install.

Canada owns thirty-eight per cent. of the world's supply of pulp wood, although it is only producing four per cent. of the world's paper. The United States has eighteen per cent. of the world's supply of pulp wood and makes forty-two per cent. of the paper.

FIXED CARBON TEST EMPIRICAL

THE SECOND OF A SERIES OF ARTICLES BY PROMINENT CHEMISTS REGARDING THE VALUE OF LIMITING THE PERCENTAGE OF FIXED CARBON IN ASPHALT

By LEROY M. LAW,

Chemist, The United States Asphalt Refining Company

UNDER ideal conditions, purchasing under specifications is beneficial to both consumer and producer. The former is enabled to state in precise terms his exact requirements in the way of material needs. This establishes quality and, as a result, all competitors are placed upon an equal footing, and competition resolves itself into the real objective: competition in price alone.

To the producer it means, first of all, that he is given an equal chance with others in the trade, and as all deliveries are to be rapidly inspected, he feels safe that another dealer cannot submit a profitless price in the hope of furnishing an inferior article. The mutual understanding, or to use the definition of contract, the "meeting of minds," is brought about through the agency of the specification proper and it is therefore highly important that this feature should receive serious consideration.

Its prime object is to define the requirements in terms which permit of ready interpretation, avoiding all possible uncertainties which may give rise to disputes under the contract. This point is vital and really forms the foundation of this great system, yet even in some of our most elaborate specifications its importance is frequently neglected.

In many of the early types we have seen such requirements as "The material must be . . . brand or equal thereto" and "the material shall have given satisfactory service under similar conditions for such a period of time." With such crude clauses, specifications fail of their purpose, for the actual requirements are at best but vaguely stated, and the producer has no way of ascertaining if his wares are "equal to" or have "given satisfactory service" in the judgment of him who reviews the bids and makes the award.

Such conditions, especially unfair to the manufacturer, are, it is true, rapidly disappearing, yet to-day, in many of the so-called scientific specifications, the adoption of requirements based on arbitrary methods of analysis has placed the honest producer in an equally uncertain and embarrassing position. One of the requirements of this nature, which has gained, and still holds, surprising popularity in many current bituminous specifications, is that limiting the so-called "Fixed Carbon." It is, indeed, difficult to understand just how this requirement even secured a foothold in asphalt specifications.

"Fixed Carbon" is a test stolen from fuel chemistry, where it serves to indicate the coke remaining after the gaseous constituents have been removed by heating the material, with exclusion of air, under prescribed conditions. Those who have had any experience whatever in fuel work know full well that this test is purely empirical and that the variations among different operators, especially in different laboratories, is often considerable.

A committee of the American Chemical Society gave considerable study to the matter some years ago and in 1899 recommended the procedure (see J. A. C. S. Vol. XXI., No. 12) that is now followed in conducting this determination. It is understood, however, that this method is not applicable even to some fuels like lignites, which are very prone to spark. How much more inapplicable, then, will the method be to softer materials, like the asphalts and road oils, which have also the disagreeable tendency of foaming out of the crucible at certain stages of the heating.

Chemists should know that city illuminating gas, their source of heat, varies in different localities. In fact, in some cities the composition is entirely different from that of others, hence a variation in heat, to say nothing of the difference in type and condition of the burners employed. It has been found that the degree to which the platinum crucible is polished has also an effect on fixed carbon results, and there are doubtless other sources of variation not as yet discovered.

The point is that engineers and chemists who advocate such requirements in their specifications, fail to realize these features, and their resulting effect on accuracy. Fieldner, of the U.S. Bureau of Mines, in speaking of the Fixed Carbon test, (see J. I. E. C., Vol. 5, No. 4) makes the following statement in regard to coal, and what he says in regard to coal is equally applicable to the fixed carbon in asphalts, for the same procedure is used with both materials:—

"The volatile matter and fixed carbon represent the relative proportions of gaseous and solid combustible matter that may be obtained from the coal by heating it in a closed vessel. This is done by heating a finely powdered sample in a small covered platinum crucible, in the flame of a Bunsen or Meker burner, for exactly seven minutes. The volatile matter consists mainly of the combustible gases—hydrogen, carbon monoxide, methane, and other hydrocarbons and some non-combustible gases, such as carbon dioxide and water vapor. The volatile matter does not include water present in the coal as moisture at 105° C. (221° F.).

"The residue of coke left in the crucible after deducing the ash is reported as 'fixed carbon.' The 'fixed carbon' does not represent the total carbon in the coal, as a portion of this element is driven out in combination with hydrogen in the volatile matter; furthermore, 'fixed carbon' is not pure carbon, but still contains several tenths per cent. each of carbon, hydrogen and oxygen; from 0.4 to 1.0 per cent. nitrogen; and about half the sulphur that was in the coal.

"It should be clearly understood that the terms 'volatile matter' or 'volatile combustible matter' and 'fixed carbon' do not represent any definite compound which existed in the coal before heating. The method of determination is purely arbitrary and variations of temperature and rate of heating will cause variations amounting to several per cent.; even with a strict adherence to the method recommended by the American Chemical Society, variations of three and four per cent. in both the volatile matter and fixed carbon may occur in different laboratories. One of the most prominent factors in causing variations is the temperature at which the crucible is heated.

"It is especially pronounced in anthracite and semi-bituminous coal. It is not improbable for one laboratory to report 4 per cent. and another 7 per cent. volatile matter on the same sample of anthracite, or 14 per cent. and 17 per cent. respectively on the same sample of Pocahontas coal.

"The different percentages of volatile matter were actually produced by different conditions of heat treatment. Caution must, therefore, be observed in making comparisons of the volatile matter and 'fixed carbon' in proximate analysis made in different laboratories. Even determinations made at the same laboratory by the same analyst may vary to the extent of 0.5 per cent."

If such wide variations do occur with coals, what, then, should we expect when the method is applied to soft asphalts and even oils? As a chemist of one of the large asphalt companies, I have observed this fixed carbon requirement enforced to extremes and yet to no purpose or benefit to the consumer. The yield of fixed carbon cannot be controlled in the process of manufacture, unless through gross carelessness in coking material. In this case, the defects will be shown far more accurately by increased insoluble matter in the various reagents employed in bitumen analysis.

Some weeks ago the writer prepared two samples of bituminous material of different consistencies, dividing each sample into several portions. These were sent to several laboratories to make the fixed carbon tests. The operators selected were not the usual commercial laboratories, but chemists who are especially qualified and equipped for asphalt work, and regarded as our foremost experts in the branch of the profession.

The tabulated results of their work follow:—

Results on Fixed Carbon.

	Sample No. 213.	Sample No. 215.
Laboratory A	12.00%	17.4 %
" B	13.62%	16.85%
" C	10.91%	13.13%
" D	12.52%	17.54%
" E	12.63%	17.20%
" F	17.10%	22.00%

Inspection of the figures shows a variation in fixed carbon on these same samples of over 6 per cent. in one case and nearly 9 per cent. in the other! When experienced operators such as the above differ by these amounts on identical samples, is there any wonder that with chemists generally the variations are even greater?

It is to be regretted that chemists do not study these tests before incorporating them in their specifications and extend to good materials and their honest manufacturers a just consideration. If fixed carbon in Baltimore is different from fixed carbon in Pittsburgh and, if in any one place the results are to vary from day to day, what possible value can the test have as indicating the value of a material? Furthermore, how is the manufacturer to test his products in every consumer's laboratory, to ascertain conditions prevailing in each of them?

Some days back it was our misfortune to have a shipment of asphalt rejected because the fixed carbon, as determined in the customer's laboratory, ran from one-tenth to three-tenths in excess of the prescribed limit. I had previously tested the batch from which this shipment was made, and found the fixed carbon considerably below the requirements of the specifications. Think of a scientist holding up a material on such a narrow margin as this, when even the most precise chemical methods are seldom within this limit of accuracy, especially as carried out in ordinary commercial testing. An absurd feature of the case is that another carload from the same batch was accepted as meeting the requirements, the inspecting chemist doubtless being unconscious of the variation he was experiencing in his own laboratory.

Suffice it to say that such a clause as Fixed Carbon, in its present empirical state, and coupled with a narrow and rigid interperation, is not only a discredit to the profession, but destroys the value of a sincere specification.

It has been stated that the principal object of the specification is to lay before the manufacturer in a clear, concise manner the requirements that are to be met. When he is unable to interpret these with a reasonable and standard equipment, the purpose of the specification fails.

The rapid development in bituminous highway work during recent years has been accompanied with an accumulation of inspection methods, desirable and questionable ones springing up together, and the many young chemists in this field of work doubtless look upon them as methods of established scientific value. Other chemists, with only time for routine work of testing, become advocates of such requirements as they might otherwise suppress. Furthermore, specifications of one city or municipality are frequently copied from those of another which, presumably, from a longer experience in bituminous work, is looked upon as a criterion in such matters.

And so, by these and other unstudied procedures, some asphalt specifications have been brought to this present empirical condition, and the time is at hand for chemists in this branch of the science to co-operate in weeding out the tangled field of laboratory methods. No one chemist should, and no true scientist will, decide that check results in his own laboratory establish the reliability of a test or method of analysis. Such is at least to be expected.

A true scientist will endeavor to ascertain what the procedure shows in the hands of others, presuming, of course, average qualifications in experience and skill.

If, as a result of such study, "Fixed Carbon" is found to be of value, then it will be of interest to all concerned to adopt definite procedures and agree on the imitations of accuracy. If it cannot be developed into real scientific test, capable of yielding concordant results in the hands of all qualified chemists, then it should by mutual consent be abandoned.

In its present empirical condition, it cannot be of any possible assistance in determining the quality or even the uniformity of a product but, on the other hand, its employment frequently works injustice to valuable materials.

Until the status of the "Fixed Carbon" test is better established, would it be any more than fair to manufacturers to omit such a requirement from bituminous material specifications?

Postmaster-General Samuel, of London, Eng., has appointed a committee of scientists to investigate the subject of wireless telegraphs and report on possible improvements for the service on land and sea. The Right Honorable Charles Edward Henry Hobhouse, chancellor of the Duchy of Lancaster, is chairman of the committee.

THE SELECTION OF MATERIALS FOR MACADAM ROADS.*

By Logan Waller Page,
Director U.S. Office of Public Roads.

Of all the factors which go to make up the perfect macadam road, there is undoubtedly none more potent than that of the suitability of the material which enters its construction. A road may be located, drained and constructed along the very best lines and according to the most approved methods and be a total failure if the material of which it is built has been poorly chosen. It is perhaps not too much to say that large sums of money are wasted annually in this country because too little importance is attached to this phase of the road problem. The engineer is then, at the very outset, confronted with the important problem of selecting the most suitable material for his work, and on the care with which he performs this task depends in a large degree the success or failure of the road he is to build. The purpose of the present paper is to discuss in some detail the methods which may be used in approaching this problem, with special reference to the value of laboratory tests as an aid in the selection of suitable materials for roads.

There are two ways in which the engineer may avail himself of the information necessary to a proper selection of a road material. The first and only certain one is to make an actual service test on the material under observation, and under the same conditions of traffic and climate to which the proposed road will be subjected. This method is, of course, impractical except in certain rare instances, due to the length of time which must elapse before definite results can be obtained. The second method is, by means of short-time laboratory tests to approximate as nearly as possible the destructive agencies to which the material will be subjected on the road, supplementing the knowledge thus gained by a study of the results already obtained in practice on material of a similar nature.

The laboratory testing of road building materials originated in France over forty years ago, and was introduced into this country by the writer in 1893, when he became Director of the Road Material Laboratory of the Lawrence Scientific School at Harvard University. The United States Government became interested in this work shortly afterwards, establishing, in 1900, a laboratory in the Department of Agriculture, at Washington. This laboratory is now a part of the Office of Public Roads, and has thus been able to give much assistance throughout the country in regard to the proper selection of material for macadam roads.

The three most important properties which a rock should possess in order that it may successfully resist the destructive agencies to which it is subjected are hardness, toughness, and cementing value.

Hardness, from the road builder's point of view, may be defined as the resistance which a rock offers to the displacement of its surface particles by friction. It is well illustrated in practice by the grinding action of iron-tired vehicles which tend to reduce to dust the rock fragments of which the road is composed. This property is determined in the laboratory by a special method, the essential features of which are as follows:—

*Read at American Road Congress, Detroit, Mich., Sept. 29 to Oct. 4, 1913.

A core 25 mm. in diameter is drilled from a sample of solid rock by means of a core drill. After being accurately weighed, it is held in a perpendicular position against a cast steel disc revolving at the rate of thirty-three revolutions per minute, while crushed quartz sand of a standard size is fed upon the disc to act as the abrasive agent. After one thousand revolutions of the disc, the core is again weighed, the loss calculated, and a measure of the hardness of the rock thus obtained.

Toughness, or resistance to impact, is a measure of ability of a road material to resist the pounding action of traffic such as is caused by the shoes of horses, etc. It is determined in the laboratory in the following way:—

A cylindrical test specimen of the rock 25 mm. by 25 mm. is taken from the core used in the hardness test, and subjected to the impact of a two-kilogram hammer through a spherical end plunger in a machine especially designed for the purpose. The test consists of a one-centimeter drop of the hammer for the first blow, followed by an increase in the drop of one centimeter until failure of the test piece occurs. The height of blow at failure is taken to represent the toughness of the specimen.

The combined effect of the mechanical agencies causing wear is very effectively determined by means of the Deval abrasion test, which has been the standard for over thirty years, and which is conducted essentially as follows:—

Five kilograms of the rock to be tested is broken so as to number as nearly as possible fifty pieces, and is placed in an iron cylinder, mounted in such a way that the axis of the cylinder is inclined at an angle of thirty degrees with the axis of rotation of the machine. After ten thousand revolutions of the machine at the rate of thirty-three per minute, the material is taken out and sieved through a 0.16 centimeter sieve, the material passing being that used in calculating the percentage of wear.

The cementing value of a road stone is that property which causes the fine rock dust to act as a cement and thus bind the coarser fragments of which the road surface is composed into an impervious shell. A laboratory test to determine this property was devised several years ago by the writer, and is conducted substantially as follows:—

Five hundred grams of the material to be tested is broken to about pea size, and placed, together with a sufficient quantity of water, in an iron ball mill. Five thousand revolutions of the mill reduces the mixture to the consistency of a stiff dough, which is moulded by means of a hydraulic moulding machine into cylindrical briquettes 25 mm. by 25 mm. in size. After drying twenty-four hours, these briquettes are tested by impact in a machine especially designed for the purpose. A one-kilogram hammer falling upon an intervening plunger, which in turn rests upon the test piece, is allowed to drop from a height of one centimeter until failure of the specimen occurs. The number of blows causing failure is used to represent the cementing value of the material.

It will readily be seen from the foregoing that a very accurate preliminary idea of the properties of a road stone may be obtained by means of laboratory tests. Many years' experience in testing these materials have made it possible to adopt certain standards of excellence which, when used intelligently and in conjunction with the other factors in the case, are of much value in selecting suitable materials for water-bound roads.

The results of laboratory tests alone, however, are not sufficient to judge of the suitability of a rock for road building purposes, unless supplemented by additional information as to, (1) the character and volume of the traffic to which it is to be subjected; (2) climatic conditions under which it is to be used, and, (3) its name and general character, including, if possible, its mineral composition. In addition to the above, consideration in any specific instance should be given to such matters as the availability of the material, especially with reference to cost, transportation facilities, etc.

The value of taking these factors into consideration will be briefly illustrated below.

It is a well-known fact that a given road rock is far from being equally well suited to different traffic conditions. A high-grade trap rock would be as unsuitable as it would be uneconomical on a road subjected to light traffic, in that the dust worn off would not be sufficient to bind the coarser fragments together, and the road would consequently ravel. On the other hand, the comparatively soft limestone would be well adapted for the light traffic road would quickly pound to dust if subjected to conditions which would hardly affect the trap.

As a general rule, it may be said that the ideal rock for any particular road should be just so hard and tough that the fine material worn off by the action of traffic would be sufficient to supply that lost by the physical agencies of wind and rain. By correlating the information obtained by observing the behavior of the various rock types under different traffic conditions, with the results of laboratory tests on material similar in character, it has been found possible to determine quite definitely under just what conditions any given material would be most suitable, even before it had ever been used in road construction.

Many years of observation of the behavior of the various road building rocks in service has demonstrated the fact that, as a general rule, certain classes of material possess for particular purposes distinctive advantages over others. It is obviously of advantage, therefore, to know the general type of the material under observation, in order that an intelligent comparison may be made between it and the material of a similar nature which has already been used. The different varieties of trap, for instance, such as diabase, basalt, etc., are generally considered to make the most satisfactory road material, especially when the traffic is heavy enough to supply by wear the dust lost from natural causes. The limestones, as a class, being softer and less tough, are, as a rule, better adapted for light traffic than the traps. Laboratory tests in these cases are, therefore, mostly of value in enabling the engineer to make a definite choice between a number of materials which in a general way might be considered as suitable for his work.

The granites, owing to lack of toughness and cementing value, are, as a rule, only suitable for the foundation courses in plain macadam construction. Here the value of taking into consideration the character of the rock tested may be illustrated by the fact that frequently granites are found by laboratory tests to have good cementing values, due to highly altered minerals, when, as a matter of fact, such material should not be used on account of the ease with which it disintegrates under traffic.

Foliated material, such as gneiss, schist, slate, etc., should never, of course, be used when better material is available. Material such as quartzite and marble should also be avoided, the first on account of its hardness and lack of cementing value, and the second because of its crystalline structure and general lack of durability.

The availability of various materials considered for use in road construction should, of course, be considered, and is highly important, especially from a financial standpoint. In considering this point, however, care should be taken not to lose sight of the other factors in the case. Experience has shown in innumerable instances where poor material has been used because it was cheap that money would have been saved in the long run by the use of a superior rock, even though shipped from a distance and costing considerably more at the outset. There are cases, however, where local material may be used advantageously. It is in such instances as these that engineering judgment, combined with laboratory results, is necessary for proper selection.

An accumulation of data resulting from the great number of tests made on road building rocks in the government laboratory has quite recently made possible some very interesting investigations concerning the relation between the properties of hardness and toughness. By plotting numerous values of these tests, it was found that, in a general way, hardness increases with toughness and that, whereas for low values of toughness the hardness was extremely variable, as the rock became tougher the hardness showed less and less deviation from an average of the plotted points. The significance of this fact is that the property of hardness appears to be invariably associated with that of toughness, although the reverse is not the case. It seems, therefore, that for a quick determination of the qualities of a road-building rock, the hardness test might possibly be omitted, since material which satisfactorily passes the toughness requirement invariably appears to be hard enough for use in road construction.

When rock is to be used in bituminous construction, the importance of some of the above-mentioned tests is diminished. The cementing value, for instance, may be practically disregarded when the use of an artificial binder removes the necessity for dependence upon a dust bond. A tough rock is, of course, preferable, and more especially when the surface is to withstand the shock of heavy traffic, but both toughness and per cent. of wear become less important in the body of the road with bituminous construction when the surface is maintained by occasional surface treatments to preserve a wearing mat with a hard and tough aggregate.

Since public health and comfort have universally demanded an abatement of the dust nuisance, and economic maintenance is correlated with their demands, a few words on the selection of dust preventives and road binders cannot be out of place in a discussion of materials for macadam roads. The selection of a form of treatment or construction must be governed by a full consideration of the volume and character of traffic which the road surface is called upon to carry. In rural sections where a macadam road is subjected principally to the average farm traffic and a relatively small number of automobiles, a surface which is in good condition at the outset may be economically and satisfactorily maintained by an occasional application of one of the lighter dust laying tars or oils. The purpose in a case of this character is simply to presrve an already good surface by keeping the products of wear saturated with a material that will prevent them from being removed from the road surface. This purpose is readily best accomplished by a product that is not possessed of marked binding qualities —a material that will not pick up nor "ball" when mixed with dust only. Hygroscopic salts and other non-bituminous dust preventives have also served the above purpose successfully where climatic conditions favor their particular characteristics.

The value of a simple dust preventive decreases, however, with an increase in the volume of automobile traffic, and a more permanent form of wearing surface then becomes necessary. Up to a certain limit, and particularly on park roads, this character of traffic is successfully provided for by means of an annual surface treatment of oil or tar covered with cleaned screenings or fine gravel. For cold surface treatment, the oils which give particular satisfaction are the natural or partially refined products which, through laboratory tests, are shown to consist of low-boiling constituents carrying in solution a relatively high amount of heavy adhesive asphaltic base. For most successful surface treatment, it is essential that an oil shall develop decided adhesive qualities in the residue from the standard volatilization test at 63° C. Tar products should be free from water, and it is believed that their value for surface treatment increases with the decrease in the free carbon content.

When the traffic becomes of such a character and magnitude as to cause a too rapid deterioration of a surface mat, the macadam must be constructed or resurfaced with a heavy binder as an integral part of the upper two or three inches of the wearing surface. The selection of a binder, whether it be a tar or asphalt product, now becomes dependent on several factors, among which the method of construction, character of the aggregate, and climatic conditions are most important. For instance, a dense aggregate may permit of the use of a lighter tar than will a poorly graded one; or a lighter tar or softer asphalt product would be specified for northern latitudes rather than for use in the south. A single standard for all materials and conditions can not, therefore, be established, but with the various factors in mind a specification can be drawn to cover the consistency and desirable chemical characteristics. In fact, in the purchase of road materials for whatever purpose it should be to the advantage of the producer as well as a protection to the consumer, that a definite specification be required. All shipments when received should be submitted to laboratory tests that will insure fulfilment of these specifications.

LONDON'S WATER STORAGE AND SUPPLY

In the annual report of the Metropolitan Water Board, of London, England, it is shown that the board has under its control subsidence and storage reservoirs of a capacity of some 15,000,000,000 gallons. The normal consumption of the 6,688,555 people within the board's area is more than 200,000,000 gallons per day. For the year ending March 31st, 1913, the total amount of water supply was 86,248.9 million gallons, or 387.9 million tons. The average daily consumption per head was 35.49 gallons, compared with 36.49 gallons in 1911-1912. The usual daily allowance could be supplied from the reservoirs if they were all filled to their utmost capacity, for eleven weeks; and as a rule the board keeps in store a supply sufficient for forty days. The southern and western districts of the city are supplied from the waters of the Thames, the southern district consuming the largest of all portions of the city—e.g., 25.45 per cent.; the new River district is furnished from the River Lee, the Chadwell springs, wells in the Lee Valley, and the Thames, and the eastern district from the Lee River principally, to the extent of 69.95 per cent., and its remaining percentage from the Thames.

PRODUCTION OF PETROLEUM IN CANADA.

The following interesting information concerning the production of petroleum is given in the report on Economic Minerals and Mining Industries, recorded by Mr. J. McLeish, and issued by the Department of Mines, Ottawa:—"At the present time the principal oil fields in Canada are situated in the peninsula of south-western Ontario, between Lake Huron and Lake Erie. The first oil was found in Lambton County in 1862, and active production has been continued ever since. Until 1907, the Lambton County fields in which there has been about 11,000 producing wells were by far the largest producers; since then, several new districts have been opened up, the most prominent ones being the Tilbury district in Kent county and the Onondaga district in Brant County. The oil districts are all situated within an area underlain by Devonian strata, usually on an anticlinal axis, and the petroleum is largely obtained from horizons in the Onondaga formation at depths varying in the different localities. When the wells are first drilled, the natural pressure is usually sufficient to force the crude oil to the surface, sometimes producing what are known as gushers. After the flowing period, the oil has to be pumped. While some of the smaller districts became exhausted in a few years, many of the pools being only a few hundred feet wide and perhaps a quarter of a mile long, others have continued to furnish oil for a long period. Four refining companies are operating in Canada distilling about 10 million gallons of Canadian crude oil per year, but the greater part being distilled at these refineries is still being imported from the United States. The total production for Canada for the year 1912 was 243,336 barrels valued at $345,050. In New Brunswick, in the district lying 11 miles to the south of Moncton, oil is being pumped in small quantities from the holes which produce the gas of this district. Although the production so far is not large, drill holes are continually being sunk, and it is hoped that very shortly a stronger and more continuous yield will be the result. In Alberta, although oil has not been encountered in commercial quantities, prospecting for it is being carried on vigorously, and there is every probability that this province will be added to the list of producers at a very early date. In connection with the oil industry in Canada, mention should be made of the existence of extensive deposits of bituminous shales and tar sands. Beds of bituminous shales, as at present recognized, are found in Gaspe, New Brunswick and Nova Scotia. Those in New Brunswick are without question the most important. They occur in the counties of Albert and Westmorland and extend in an easterly and westerly direction over a distance of 40 miles. During the past 10 months extensive exploration, by means of diamond drilling and surface work, has demonstrated not only the quantity but the quality of these valuable deposits. It is anticipated that in the near future a plant, with a capacity for an initial daily treatment of 2,000 tons of shale, will yield approximately 80,000 gallons of crude oil per day. Tar sands are known to occur in Alberta along the Athabaska River for a distance of upwards of 100 miles north and south of Fort McMurray. Although the existence of these deposits has been recognized for many years, no steps have as yet been taken to accurately determine their possibilities."

The estimate of $1,500,000 as the net manufacturing profits of the Spanish River Pulp and Paper Mills for the current year will be noted for reference a year hence. The corresponding profits for the combined companies in the year ended June 30th were approximately $350,000, so an increase of something more than 300 per cent. is anticipated.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MINING, MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

Present Terms of Subscription, payable in advance.
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (7s.)	$1.00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

JAMES J. SALMOND—MANAGING DIRECTOR.
HYNDMAN IRWIN, B.A.Sc., EDITOR.
A. E. JENNINGS, BUSINESS MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto."
Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.
Winnipeg Office: Room 820, Union Bank Building. Phone Main 2914. G. W. Goodall, Western Manager.
Address all communications to the Company and not to individuals.
Everything affecting the editorial department should be directed to the Editor
The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

SUBSCRIBERS PLEASE NOTE:
When changing your mailing instructions be sure to state fully *both* your old and your new address.

Published by the Monetary Times Printing Company of Canada, Limited, Toronto, Ontario.

Vol. 25. TORONTO, CANADA, NOV. 20, 1913. No. 21

CONTENTS OF THIS ISSUE.

WATER WASTE IN CITIES.

Last week the subject of excessive waste was broached in these columns in connection with the water consumption of one of our Canadian cities. It is a subject that should have more attention in many cities and towns, as in some of them there appears to be little or no effort at conservation. It is not implied, of course, that the aim should be to have consumers economize in the legitimate use of water, but rather to show that cases are prevalent where, so long as there is water in the reservoir, the profligate waste goes on unchecked. Misjudgment in this respect has frequently caused alarm and danger.

Considering the fact that the majority of water supplies throughout the country have to be pumped once, and sometimes twice, that many of them are filtered, and some of them chemically treated, water should cease to be regarded "as free as air," as it is in reality a manufactured product with manufacturing costs accompanying it.

It is interesting to note the procedure in Philadelphia, not many years ago regarded as the most pronounced in water wasting of the larger cities. A year ago a water waste campaign was established. It was begun by securing an ordinance allowing the installation of water meters. This was followed by a Water Conservation Show, where meters and other water-saving appliances were exhibited. A large force of inspectors, under good supervision, began a house-to-house inspection, and during the year practically the entire city has been covered twice in this way. Hundreds of thousands of leaky fixtures were located and repaired.

An exhaustive campaign for the detection and repair of street leaks has been going on. This work is made possible largely through the use of the pitometer and the microphone, and is done for the most part between midnight and 4 a.m. The night flow in most districts is a good measure of unwarranted waste, and through the use of the microphone water running far below the surface can sometimes be distinctly heard, when the noise of daily traffic is absent.

By the elimination of undue waste of water, Philadelphia has added materially to its water pressure, both for fire and home purposes. That the campaign for its conservation has been successful is demonstrated by the reduced amount of water pumped. In West Philadelphia, where the work has been very thoroughly done, the daily pumpage has been reduced from 45-48 million gallons to 32-35 million gallons within a year. An interesting index of the smaller demand on the pumping stations is the fact that they are burning 3,000 tons less coal than for the corresponding month of last year.

PERMANENT HIGHWAYS URGED BY COUNTIES.

Following the two sessions recently held by the Public Roads and Highway Commission, at Ottawa and Belleville, a third sitting took place in Hamilton on Nov. 11th, which has undoubtedly added much to the body of information to form the basis for action toward a provincial system of road-making and maintenance on the most approved plan. The general feeling at the Hamilton meeting was that the main roads should be made provincial highways, to be constructed and maintained by the Provincial Government, under the supervision of a highways commission. It was recommended that the construction be of a permanent nature, suitable for present-day traffic and the traffic that is likely to follow the construction of these permanent roadways.

In the matter of financing the construction of such provincial highways, it was recommended that the property benefited by such roads should be assessed 25 per cent. of the cost, to be spread over a reasonable number of years. The cities, towns and villages that are connected up with the provincial highways also to pay 25 per cent. of the cost, to be apportioned on the basis of population, the balance of 50 per cent. to be paid by the Provincial Government. The meeting, however, was strongly of the opinion that the Dominion Government should assist by paying a portion of this 50 per cent.

It was further urged that a reasonable tax be placed upon motor-driven vehicles in the Province, the proceeds of this tax to be used for the maintenance of Provincial roadways, this maintenance also to be under the supervision of the government highways commission.

Regarding the secondary roads and feeders to the Provincial highways, a more comprehensive system was urged. These roads should be county roads, and financed as at present by the Government paying one-third of the cost, the counties to be assisted by the commission in the selection of roads best adapted for feeders.

Such opinions were embodied in a resolution jointly presented to the Commission by the Board of Trade, the Manufacturers' Association and the Automobile Club. Unlimited confidence seems to be reposed in the ability of the Provincial authorities to make and maintain roads that will bring the producer and consumer more closely together for the benefit of the Province generally. It is the feeling among practically all counties that the responsibility of such an undertaking is of so great an extent that the Provincial Government should assume a portion of it, if the roads of older Ontario are to meet with material improvement.

MUNICIPAL CONTROL OF PUBLIC UTILITIES.

The National Municipal League, which held its 19th annual meeting in Toronto last week, entered into a thorough discussion of municipal enterprise, and municipal government, and closed with a very important paper by Dr. Delos F. Wilcox, of New York, on the "Rights of Local Municipal Control as Against State or Provincial Control of Public Utilities." The speaker drew his arguments from the experiences of nearly every important city in the United States. Dr. Wilcox is a prominent authority upon public utilities, having been recently associated with the Public Utilities Commission of New York, as an expert on franchises.

Local control, according to Dr. Wilcox, is becoming more and more essential every year to the successful administration of the affairs of cities and larger towns. He believes that in America there is a tendency towards too great a centralization in the control of public utilities, and that certain features of exclusive state regulation tend to make the municipalization of utilities more difficult.

After reviewing the arguments in favor of State control, in which he showed how local telephone and electric railway systems often overlap municipal boundaries and even transcend State boundaries and how the development of hydro-electric power has necessitated wide fields of distribution, thus almost demanding State control, Dr. Wilcox showed that most public utilities are primarily urban in character and are developed primarily in relation to one or more urban centres. It was necessary to localize the control of these, therefore, as much as possible. The more powerful private corporations operating public utilities become, and the more widespread their services, the more important it is that they should be directly answerable to the local communities which they serve.

With regard to the control and financing of the extensions of public utilities in a city, Dr. Wilcox said: "I believe that a public utility within a given urban community is a natural monopoly, and that one of the first and essential obligations of such a monopoly is to extend its services to meet all the legitimate needs of the community. In practically every city," he continued, "where there is a street railway situation, one of the greatest difficulties is found in the absence of public control in the matter of extension. There is nothing which the people of a growing city so insistently demand as extensions of street railway systems, and there is no point where the street railways more strenuously refuse to recognize public initiative and control than in the building of additional lines. A few cities have covered the problem of extensions more or less successfully in their franchise contracts. This is notably the case in Chicago and Cleveland, and the principle is recognized in the new subway contracts in New York."

CONVENTION—AMERICAN ROAD BUILDERS' ASSOCIATION.

In our issue of Oct. 2nd, (page 537) we presented the tentative programme of the Tenth Annual Convention of the American Road Builders' Association, to open in Philadelphia on December 9th.

Owing to a few important changes that have been made in the programme, it is published herewith as now arranged. It deals with twelve important subjects introduced by papers by the leading highway commissioners, engineers and experts. Discussions are being previously prepared.

Subject A.—Organization.

1. Highway Officials, Their Duties and Powers.

2. Division of Expense, Responsibility and Authority Between Nation, State, County and Town.

3. The Relation to Each Other of the Contractor, Engineer and Inspector.

4. Details of Arrangements for the Use of Convict Labor.

Subject B.—Construction.

1. Determination of the Amount of Realignment, Grading and Drainage to Be Done in Connection With Road Improvement.

2. Factors Governing a Proper Selection of Road or Street Pavement.

3. Details of the Construction of the Various Kinds of Roads and Pavements.

Ten-minute papers on the following subjects: Earth Roads; Sand-Clay Roads; Gravel Roads; Water-Bound Macadam; Bituminous Macadam and Bituminous Concrete; Brick; Concrete; Wood; Granite and Asphalt Block; Sheet Asphalt.

4. Unit Price and Lump Sum Contracts and Percentage Work.

5. The Testing of Material for Road and Street Construction.

Subject C.—Maintenance.

1. Sub-Organization for Securing Efficient Maintenance.

2. General Methods of Repairs and Renewals.

3. Bituminous Surface Treatment and Dust Prevention.

Among those who are to take part in the proceedings are the following: Chas. J. Bennett, State Highway Commissioner of Connecticut; E. M. Bigelow, State Highway Commissioner of Pennsylvania; A. H. Blanchard, Professor of Highway Engineering, Columbia University, New York, N.Y.; Henry L. Bowlby, State Highway Engineer of Oregon; Frank W. Buffum, State Highway Commissioner of Missouri; John N. Carlisle, State Highway Commissioner of New York; Wm. H. Connell, Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.; Geo. W. Cooley, State Engineer of Minnesota; F. L. Cranford, Road Contractor, Brooklyn, N.Y.; Major W. W. Crosby, Chief Engineer, Maryland Geological Survey; A. W. Dean, Chief Engineer, Massachusetts Highway Commission; Fred E. Ellis, Road Contractor, Peabody, Mass.; A. B. Fletcher, State Highway Engineer of California; S. D. Foster, Chief Engineer, Pennsylvania State Highway Department; R. B. Gage, Chemist, State Highway Department of New Jersey; John S. Gillespie, Road Commissioner of Allegheny County, Pa.; L. R. Grabill, Superintendent of Suburban Roads, District of Columbia; H. C. Hill, Engineer, Lane Construction Co., Meriden, Conn.; A. R. Hirst, State Highway Engineer of Wisconsin; Prevost Hubbard, Consulting Chemist, Institute of Industrial Research, Washington, D.C.; Jos. W. Hunter, Deputy Commissioner, Bureau of Township Highways, Pennsylvania State Highway Department; A. N. Johnson, State Highway Engineer of Illinois; C. A. Kenyon, President, Indiana Good Roads Association; Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, New York, N.Y.; James H. MacDonald, former State Highway Commissioner of Connecticut; T. H. MacDonald, State Highway Engineer of Iowa; W. A. McLean, Chief Engineer of Highways and Commissioner of the Ontario Public Roads and Highways Commission, Toronto, Ont., Canada; R. A. Meeker, State Highway Engineer of New Jersey; Harold Parker, Vice-President, Hassam Paving Co., Worcester, Mass.; Robert J. Potts, Professor of Highway Engineering, Agricultural and Mechanical College of Texas, College Station, Tex.; Dr. Joseph Hyde Pratt, State Geologist of North Carolina; Jean de Pulligny, Engineer-in-Chief, Board of Public Works of France, and Director of the French Mission of Engineers to the United States; John J. Ryan, Secretary, Road Builders' Association, Albany, N.Y.; Frank F. Rogers, State Highway Commissioner of Michigan; Chas. W. Ross, Street Commissioner, Newton, Mass.; Paul D. Sargent, Chief Engineer, Maine State Highway Commission; Herman H. Schmidt, Chief Engineer, Bureau of Highways, Borough of Brooklyn, New York, N.Y.; Henry G. Shirley, Chief Engineer, Maryland State Roads Commission; Francis P. Smith, Consulting Chemist and Paving Engineer, New York, N.Y.; Robert C. Terrell, Commissioner of Public Roads of Kentucky; Geo. W. Tillson, Consulting Engineer to the President of the Borough of Brooklyn, New York, N.Y.; Wm. D. Uhler, Assistant Engineer, Bureau of Highways and Street Cleaning, Philadelphia, Pa.; P. St. J. Wilson, State Highway Commissioner of Virginia.

EFFECT OF HIGH PRESSURES.

CURIOUS and unlooked-for manifestations have of late been observed from the application of very high pressure. It used to be considered that heat was the only medium which would separate compound substances into their simple elements, but it has now been found that pressure is equally effective and more convenient in some respects. Salts decompose spontaneously into their component acid and metals, water yields its elementary gases, and heat consolidates into coal.

The application of very high pressures seems to be producing a positive revolution in the chemical industry, and is briefly referred to in Railway and Locomotive Engineering. Only a short time ago, the report circulated that Haber had succeeded in causing elementary nitrogen and hydrogen to react at a pressure of 300 atmospheres (4,410 pounds) and at temperatures varying between 900 and 1,080 degrees F. A remarkable reaction belonging to this category was likewise discovered by Ipatiew, who succeeded in precipitating metals from their sale solutions by hydration under high pressure. Thus, starting with cupric sulphate, he obtained finely distributed copper and sulphuric acid. There is another interesting reaction in the decomposition of water under high pressure and at high temperatures in the presence of a metal, as, for instance, iron, which binds the oxygen separated. At the same time, hydrogen of very high purity is yielded. This new method of producing pure hydrogen is of especial interest at the present time, since this gas is used for many technical purposes in various departments. Among the various modes of production that have been announced of late, the new method is probably the cheapest. The production of artificial coal under high pressure is also one of the recent inventions. Cellulose or peat is heated up with water to 612 degrees F., under a pressure of more than 100 atmospheres (1,470 pounds) in apparatus especially constructed for the purpose, the resultant being a product identical with mineral coal, both from a physical and a chemical point of view. At 558 degrees F. the process requires 80 hours, at 612 degrees F. only 8 hours are necessary for the transformation.

MOTOR TRAFFIC IN CANADA.

Over 12,400 more motor vehicles were in use in the Dominion on November 1st than at the end of last year, according the figures compiled by the Automobile Club of Canada. The following are the totals for each of the provinces, including private and commercial vehicles and motor cycles:—

	1912.	1913.
Quebec	3,597	4,706
Ontario	11,939	15,255
New Brunswick	289	789
Manitoba	3,943	5,016
British Columbia	4,666	7,044
Nova Scotia	867	1,300
P. E. Island	...	' .
Saskatchewan	3,742	6,513
Alberta	2,835	3,640
Yukon	5	15

It is rather remarkable that the largest gains among the motor vehicle using provinces were made at the two ends of the continent—in New Brunswick and the Yukon, where the increases were over 300 per cent.

STATICAL ANALYSIS OF REINFORCED CONCRETE ARCH BRIDGE

DESCRIPTION OF A RAILWAY BRIDGE OF SPECIAL DESIGN — AN ANALYSIS OF ITS STRESSES AND DEFLECTIONS — RESULTS OF TEST LOADING

By V. J. ELMONT, B. Sc., A.M. Can. Soc. C.E.

THIS bridge carries a single-track railway over the River Werra. In order to allow for future navigation it was found necessary to bridge the river in one span of 174 feet.

As will be seen in the illustrations (Figs. 1, 2 and 3) the bridge has two arches, arranged above the bridge floor; they are calculated and constructed as arches without hinges, for which kind of structure the soil (coarse gravel) was very well suited, the maximum pressure on it being only 5,000 to 6,000 lbs. per sq. ft. Above the clearance line of the cars the arches are stiffened sideways by T-shaped struts (see Figs. 2 and 4) which, together with the arches, form a strong truss. The free space between the arches is 14′ 5″, the depth of the arches at the crown is 5′ 3″ and at the springing line 8′ 2″; the rise is 34 feet.

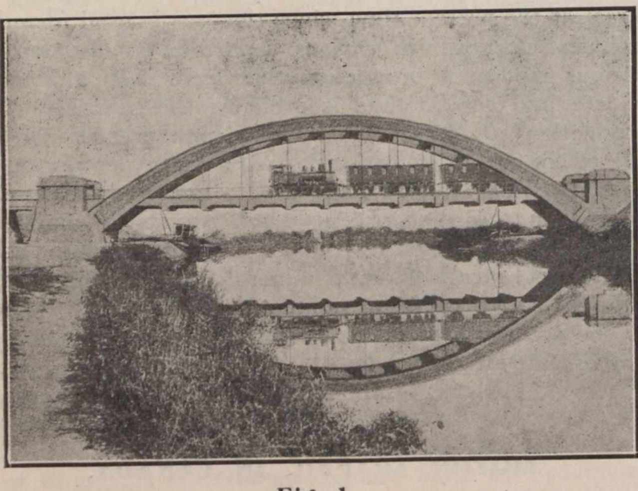


Fig. 1.

The bridge floor is suspended from the arches by means of rods, carefully anchored in the arches and floor beams. The slab which forms the direct support for the ballast, in which the cross-ties for the rails are embedded, is 5½″ thick and is carried by four longitudinal beams, which again rest on the floor beams spaced 13′ 7″ centre to centre. These are 2′ 7″ wide in the middle, tapering to 1′ 7″. This form was adopted in accordance with the requirements of the specification, viz., that the actual tension stress in the concrete should not exceed 275 lbs. per sq. in.

In order to avoid stresses in the floor produced by variations of temperature, it is divided into three parts, the two end sections being rigidly connected with the arches, while the middle section hangs freely and engages with the end sections by means of indentations; the floor will thus act as a horizontal cantilever girder for wind forces, having a simply supported part at the middle resting against two cantilever arms at the sides.

The abutments (Fig. 5) are formed by widening the arches below the bridge floor, and connecting them by a slab towards the river.

The falsework used in the construction of the bridge was given an overheight at the crown of the arches of 2″, diminishing towards the ends. It was found that the settlement of the falsework during the concreting amounted to 1⅜″ at the crown, and when the falsework was removed after the concrete had hardened for five weeks a further settlement of 7/16″ took place.

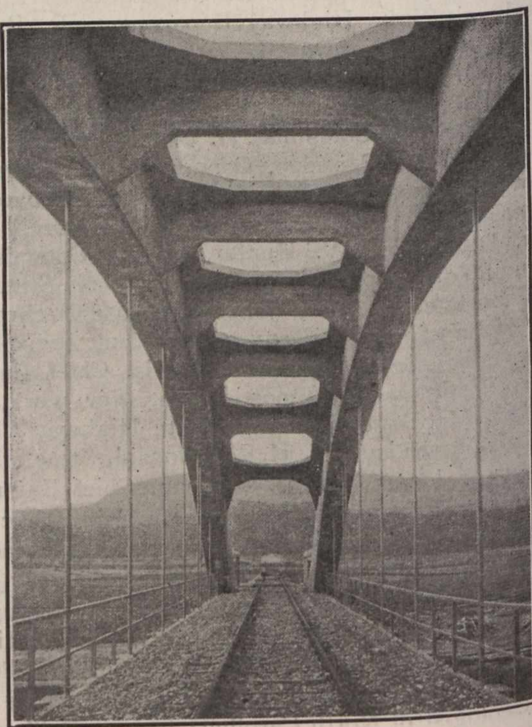


Fig. 2.

Statical Analysis.—The following maximum stresses were allowed: Concrete in compression, without regard to temperature stresses, 500 lbs. per sq. in.; concrete in compression, including temperature stresses, 650 lbs. per sq. in.; concrete in tension, including temperature stresses, 275 lbs. per sq. in.; steel in tension, including temperature stresses, 14,000 lbs. per sq. in. The calculation of the bridge floor does not include any special features.

The depth of the arches was first computed by repeated approximate figuring to $d_c = 5' \ 3''$ at the crown and $d_s = 8' \ 2''$ at the springing line, with a width of 3′ 7″, and then tested by the exact formulæ for arches without hinges. The dimension d_x for the interspacing point with the abscissa x measured from the crown was taken from the formula

$$d_x = d_c + 4\left(\frac{x}{l}\right)^2 \left(d_s - d_c\right),$$

where l is the theoretical span; it has been proved that a good variation of the cross sections is obtained by this equation.

The form of the centre line of the arches follows a funicular polygon to the dead load of the structure, which can be calculated from the above expression for d_x. The differential equation for the centre line is $\frac{d^2y}{dx^2} = \frac{g}{H}$, where g is the load per unit length and H the horizontal pressure. By integration

$$\frac{d_y}{d_x} = \frac{1}{H}\int g d_x + C; \; (\frac{dy}{dx} = 0, \text{ giving } x = 0 \text{ and } C = 0)$$

$$y = \frac{1}{H}\int d_x \int g d_x + C_1;$$

$(y = 0$, giving $x = 0$ and $C_1 = 0)$.

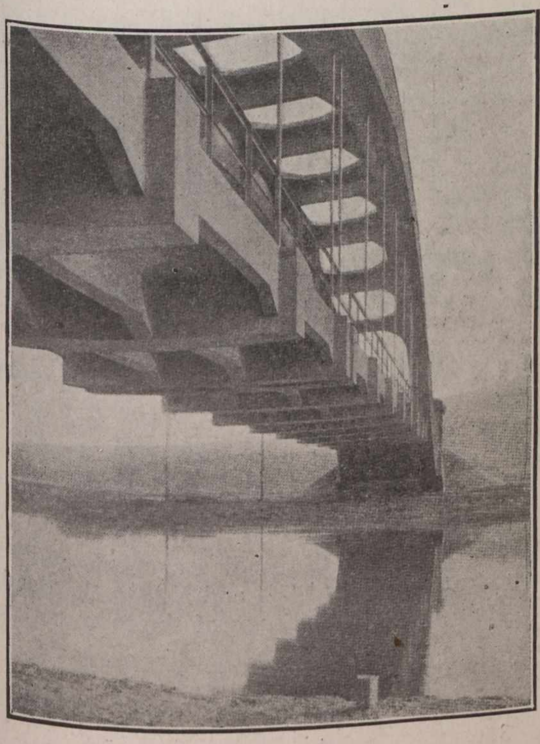


Fig. 3.

In calculating the ordinates at the various points of the centre line the integrations are replaced by summations and the rise of the arches chosen as 34 feet; the ordinates and the horizontal pressure can then be obtained from the equation for y. H for this bridge is 345 tons.

The arches, having no hinges, are statically indeterminate in the third degree. The general form of the equations by which the three unknown quantities (X_a, X_b and X_c) are calculated, are with the usual notation

$$X_a\delta_{aa} + X_b\delta_{ba} + X_c\delta_{ca} = \Sigma P_m \delta_{ma} + \delta_{at},$$
$$X_a\delta_{ab} + X_b\delta_{bb} + X_c\delta_{cb} = \Sigma P_m \delta_{mb} + \delta_{bt},$$
$$X_a\delta_{ac} + X_b\delta_{bc} + X_c\delta_{cc} = \Sigma P_m \delta_{mc} + \delta_{ct};$$

δ_{at}, δ_{bt} and δ_{ct} being the influences due to variations of temperature.

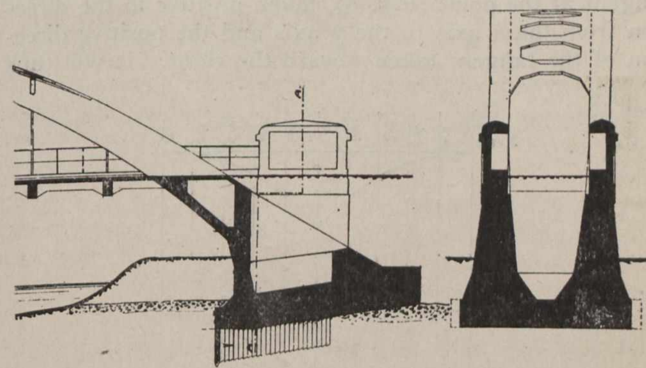


Fig. 5. Section A-A

From the theory of arches without hinges it is known that a very practicable statically determinate auxiliary system is obtained by introducing the normal force X_c, the transversal force X_b and the bending moment X_a at the crown of the arches as the statically indeterminate quantities and allowing them to act upon the arch from a point O (see Fig. 6) in the symmetrical axis of the arch determined by

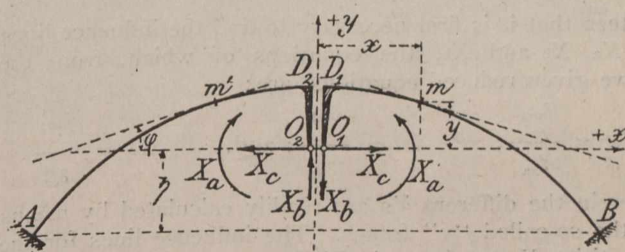


Fig. 6.

$$\delta_{ba} = \delta_{ab} = 0$$
$$\delta_{ca} = \delta_{ac} = 0$$

The equations for x will then be

$$X_a\delta_{aa} = \Sigma P_m \delta_{ma} + \delta_{at},$$
$$X_b\delta_{bb} = \Sigma P_m \delta_{mb} + \delta_{bt},$$
$$X_c\delta_{cc} = \Sigma P_m \delta_{mc} + \delta_{ct};$$

as $\delta_{cb} = \delta_{bc} = 0$, on account of the symmetry, and the statical determinate auxiliary system will be two curved beams with one fixed and one free end. (Fig. 6).

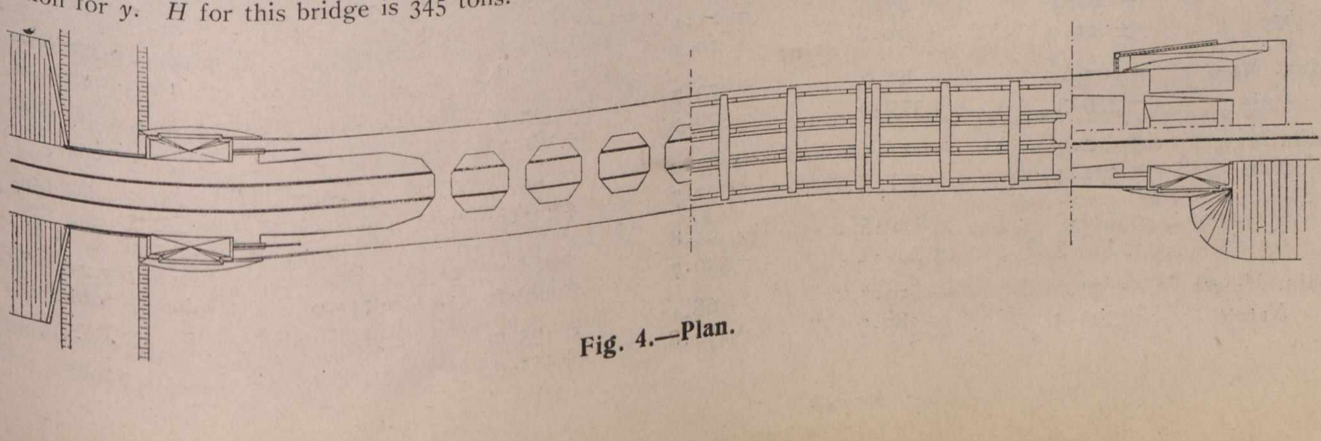


Fig. 4.—Plan.

The maximum bending moment and normal forces due to the live load in the various sections of the arches, are calculated by means of influence lines. The equations for the influence lines for the bending moment (M) and normal force (N) in the point m of the arches are:

$$M_m = M_{o,m} - X_a - X_b\,x - X_c y,$$
$$N_m = N_{o,m} + X_b \sin \phi - X_c \cos \phi;$$

$M_{o,m}$ and $N_{o,m}$ being the corresponding values in the auxiliary system, ϕ the angle between the x axis and the tangent at the point (Fig. 6), taken positive in the direction from the x axis to the y axis and the positive direction of the tangent taken toward the right. It will thus

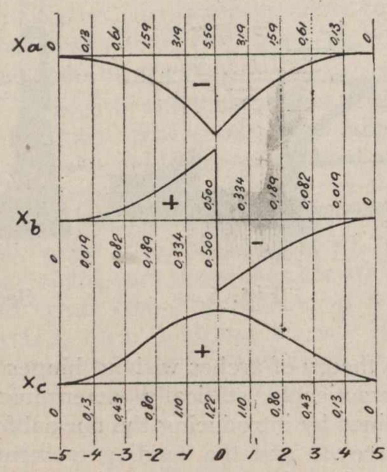


Fig. 7.

be seen that it is first necessary to find the influence lines for X_a, X_b and X_c, the equations of which, from the above given reduced equations, are:

$$X_a = \frac{\delta_{ma}}{\delta_{aa}}; \quad X_b = \frac{\delta_{mb}}{\delta_{bb}}; \text{ and,} \quad X_c = \frac{\delta_{mc}}{\delta_{cc}}.$$

wherein the different δ's are readily calculated by means of the so-called "v" forces. The influence lines for the quantities X are shown in Fig. 7, and the influence lines for the bending moments in Fig. 8.

A variation of the temperature of ± 40° F. was taken into consideration; the bending moments and normal forces produced by this change are:

$$M_t = -X_c y; \; N_t = -X_c \cos \phi,$$

$$X_a \text{ and } X_b \text{ being } = 0, \text{ and } X_c = \frac{\epsilon E t l}{\delta_{cc}}$$

in which ϵ is the elongation per unit length per 1° F., E the modulus of elasticity, t the variation of the temperature and l the span.

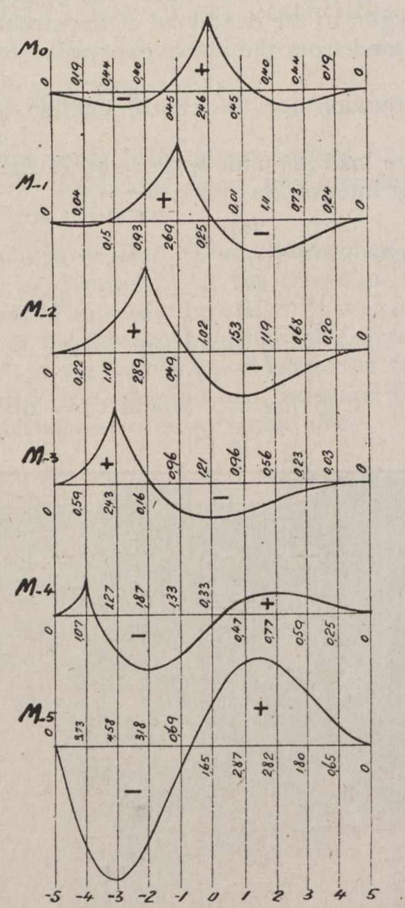


Fig. 8.

In Table I. is given the bending moments and normal forces due to the live load (M_p and N_p), to the dead load (M_g and N_g), and to the change of the temperature (M_t and N_t).

Table I.—Bending Moments (M) and Normal Forces (N).

Point.	0	1	2	3	4	5
Max. M_p	+ 34.8	+ 55.4	+ 61.7	+ 42.6	+ 40.4	+ 127.5 yard tons
N_p	+ 26.3	+ 33.9	+ 21.8	+ 12.7	+ 32.2	+ 42.5 tons
Min. M_p	— 30.0	— 38.7	— 59.0	— 52.2	— 63.0	— 163.5 yard tons
N_p	+ 38.4	+ 30.1	+ 43.7	+ 62.3	+ 49.0	+ 40.6 tons
M_g	+ 32.3	+ 27.2	+ 12.0	— 14.7	— 52.8	— 105.0 yard tons
N_g	+ 333.0	+ 337.0	+ 349.0	+ 369.0	+ 397.0	+ 435.0 tons
M_t	∓ 56.9	∓ 47.9	∓ 21.1	± 26.1	± 93.3	± 181.0 yard tons
N_t	± 21.0	± 20.8	± 20.1	± 19.0	± 17.8	± 16.3 tons
Max. M_{p+g}	+ 67.1	+ 82.6	+ 73.7	+ 27.9	— 12.4	+ 22.5 yard tons
N_{p+g}	+ 359.3	+ 370.9	+ 370.8	+ 381.7	+ 429.2	+ 477.5 tons
Min. M_{p+g}	+ 2.3	— 11.5	— 47.0	— 66.9	— 115.8	— 268.5 yard tons
N_{p+g}	+ 371.4	+ 367.1	+ 392.7	+ 431.3	+ 446.0	+ 475.6 tons
Max. M_{p+g+t}	+ 124.0	+ 130.5	+ 94.8	+ 54.0	+ 80.9	+ 203.5 yard tons
N_{p+g+t}	+ 338.3	+ 350.1	+ 350.7	+ 400.7	+ 447.0	+ 493.8 tons
Min. M_{p+g+t}	— 54.6	— 59.4	— 68.1	— 93.0	— 209.1	— 449.5 yard tons
N_{p+g+t}	+ 392.4	+ 387.9	+ 412.8	+ 412.3	+ 428.2	+ 459.7 tons

From Table II., which gives the maximum stresses, it will be seen that the maximum compression stress in the concrete is 459 lbs. per sq. in., due to dead + live load, and 610 lbs. per sq. in. when the influences due to temperature variations are added. The allowable compression stress is nearly reached in all sections, while the tension stress in the steel has the maximum value of only 6,700 lbs. per sq. in., and the tension in the concrete 196 lbs. per sq. in.

Table II.—Maximum Stresses in Lbs. per Sq. In.

e = at extrados i = at intrados

Point.	Stresses due to p+g: Compression in concrete	Tension in steel	Stresses due to: Compression in concrete	Tension in steel	Tension in concrete
0	*e* 445	*i* compr.	*e* 570	*i* 980	*i* 69
1	*e* 459	*i* compr.	*e* 552	*i* 700	*i* 46
2	*e* 405	*i* compr.	*e* 435	*i* compr.	*i* compr.
3	*i* 440	*e* compr.	*i* 472	*e* compr.	*e* compr.
4	*i* 452	*e* compr.	*i* 567	*e* 1400	*e* 94
Springing line 5	*i* 380	*e* 420	*i* 610	*e* 6700	*e* 196

In order to prove the correctness of the results derived by the above described method of calculations, a careful test loading was arranged. Three railway trucks, weighing about 48 tons each when loaded with potash

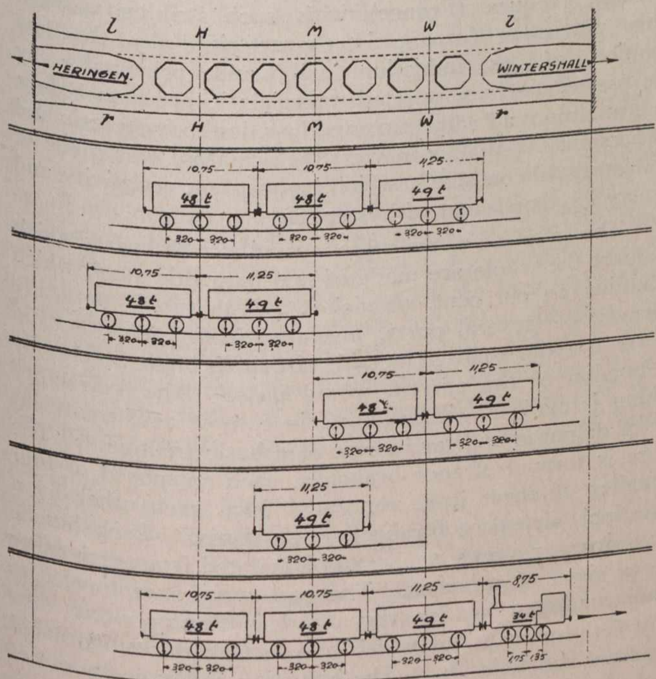


Fig. 9.

salts, and a locomotive weighing 34 tons, were used. Five different cases were examined (diagrammatically shown in Fig. 9):

(1) Three trucks placed symmetrically at the middle of the bridge.

(2) Two trucks, standing at the point at which the roadway is divided.

(3) The same as 2, at the opposite end.

(4) One truck at the middle.

(5) The whole train crossing the bridge at full speed.

The deflections were measured by means of wooden levers magnifying five times. Measurements were taken at both sides (called l and r in Fig. 9 and Table III.) in three vertical planes lettered H, M and W. The instruments were arranged in these three planes, not only under the bridge floor (called b) but also directly under the arches (a), so that the deflections were measured at twelve points in all. In Table III. are given the calculated and measured deflections. The results show a remarkably close agreement between them in all points, proving the possibility of computing correctly structures of this type. The modulus of elasticity derived from the test is 4,200,000 lbs. per sq. in., which is double that usually assumed in calculation. It must be remembered, however, that the concrete was five months old, and of

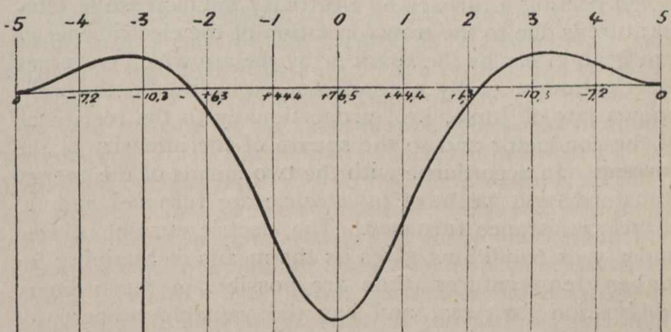


Fig. 10.

exceptionally good quality, being a 1:6 mixture of natural ballast from the Werra River with cement. Cubes of the same mixture gave a crushing strength of 5,100 lbs. per sq. in. after 28 days.

Table III.—Deflections in 1/25 of an Inch.

Loading Case	Side of Bridge	Location of Point	H Calculated	H Measured	M Calculated	M Measured	W Calculated	W Measured
1	*l*	*a*	+1.0	+1.0	+2.1	+2.2	+1.0	+0.7
		b	+1.4	+1.2	+2.9	+3.2	+1.4	+0.9
	r	*a*	+1.0	+1.0	+2.1	+2.2	+1.0	+1.2
		b	+1.4	+1.2	+2.9	+3.0	+1.4	+1.4
2	*l*	*a*	+2.5	+2.3	+1.0	+1.4	—1.5	—1.2
		b	+2.8	+2.0	+1.3	+1.3	—1.5	—1.2
	r	*a*	+2.5	+2.0	+1.0	+1.2	—1.5	—1.2
		b	+2.8	+2.2	+1.3	+1.4	—1.5	—1.2
3	*l*	*a*	—1.5	—1.2			+2.5	+2.4
		b	—1.5	—1.4			+2.8	+2.7
	r	*a*	—1.5	—1.2			+2.5	+2.6
		b	—1.5	—1.2			+2.8	+2.6
4	*l*	*a*			+1.7	+1.7		
		b			+2.5	+2.3		
	r	*a*			+1.7	+1.6		
		b			+2.5	+2.5		
5	*l*	*a*			+2.1	+2.4		
		b			+2.9	+3.2		
	r	*a*			+2.1	+2.4		
		b			+2.9	+3.2		

The deflections were calculated as bending moments produced by the "v" forces. The general expression for the "v" force, acting in the point m of the arch, is

$$V_m = \lambda M_m \frac{\sec \phi_m}{E J_m},$$

where λ is the distance between the points for which the "v" force is calculated (here 1/10 of the span), M_m is the bending moment, E the modulus of elasticity, J_m the moment of inertia at the point m, and ϕ the angle as defined above. In Fig. 10 is shown the influence line for the deflection at the crown; the figures written on the ordinates give the deflections in 1/25,000 of an inch for a force of one ton.

NOTES ON ELECTRIC FURNACES, WITH SPECIAL REFERENCE TO AN INDUCTION FURNACE.

THIS title has been given to the following paper, read at the 36th general assembly of the S.A.I. E.E., at Johannesburg on September 18, 1913, and written by Dr. W. Glucksman, D.Sc.:—

Before going into details of the induction furnace, I think it advisable to point out briefly the following facts. When heating a furnace by electricity the increase of temperature is due to the transformation of the electric energy into heat, either by the spark or by the arc which traverses the electrodes, or by a conductor according to the well-known law of Joule, i.e., proportionally to the resistance of the conductor and to the square of the intensity of the current. In accordance with the two means of the energy transformation we have (*a*) electric arc furnaces and (*b*) electric resistance furnaces. The electric current utilized under such conditions gives us the means of attaining far higher temperatures than are possible in the ordinary combustion furnaces, and has the valuable property of being easily regulated so as to maintain or vary the required temperature with a remarkable degree of precision. The use of electricity enables us also to concentrate the whole calorific energy in a relatively restricted space. In this connection I shall only remind you of Moissan's experiment, in which he concentrated 200,000 calories per second in the volume of one litre of titanic acid. Finally, the direct transformation of electric energy into heat is one of the most interesting properties of electricity, and it is owing to this property that we are able, in particularly advantageous conditions to utilize such natural sources of power as waterfalls.

In the manufacture of steel by means of an electric furnace one can start from cast iron and obtain as a result of the process any desired grade of steel, or if a more economical apparatus is available, we can use the electric furnace only in the last stage of manufacture. Naturally, to obtain the desired result we have to use one of the metallurgical processes ordinarily employed. In this paper we shall treat the electric furnace only as a handy apparatus for the manufacture of steel, for instance, without dwelling on its further valuable properties, which enable it to obtain results which cannot be obtained by any ordinary Siemens-Martin furnace.

Principal Types of Electrical Furnaces.—As I have stated above, two types of electrical furnaces are so far known, (*a*) arc furnaces and (*b*) resistance furnaces.

(*a*) *Arc Furnaces.*—Three different classes of arc furnaces are in use at present:—

1. Furnaces in which the bath communicates with one pole of the electric supply, the arc striking between the bath and one or several superior electrodes.

2. Furnaces in which the bath does not communicate with the electric source. The current enters through one or more electrodes and goes out through one or more other electrodes, after having produced as many arcs as there are pairs of electrodes.

3. Furnaces in which the arc is completely localized between the electrodes and is independent of the bath, the latter being heated by radiation.

The following are the types for the three categories of arc furnaces mentioned: The Siemens, Keller, Moissan, Stassano and Chaplet.

(*b*) *Resistance Furnaces.*—In the resistance furnaces heating is due exclusively to Joule's effect: $j = C^2 Rt$. Two classes exist. In the first the electric current passes directly into the metal to be melted; in the second the current passes into an auxiliary conductor, which heats the metal by conduction. These two classes are represented by Gin's canal furnace and the induction furnace. The idea of the induction furnace is due to Ziani de Ferranti, who patented it in Great Britain as far back as 1885. Ferranti's furnace is composed of an iron armature which has the form of a frame, and round one of its branches is wound a conductor, through which passes an alternating electric current. The secondary winding consists of a single spiral in short circuit, which amounts to a ring surrounding the other vertical branch of the frame. This ring is made of cast metal, is traversed by an induced current (the intensity of which is nearly equal to the primary current multiplied by the number of windings of the coil), and thus the transformation of electric energy into heat is made with the actual material to be heated. The Kjellin and Rhodenhauser furnaces are made on this principle.

Gassie's Induction Current Furnace.—The rapid progress of electric siderurgy revolutionized every metallurgical process. As yet we have no electric furnaces for smelting on the Witwatersrand gold mines, but the day is approaching when the electrification of the smelting furnaces will be an accomplished fact. It may be opportune to describe Gassie's induction furnace recently installed in Saint Jacques (France) with such striking success. This particular furnace is characterized by the low position of its induction coil, and principally by the use of specially selected materials in order to reduce to a minimum all eddy currents, loss due to hysteresis and dispersion. With this in view the armature was made of soft steel (silicon steel), which has a great resistivity and a very low coefficient of hysteresis.

The envelope of the masonry and also the parts which support the whole are made of non-magnetic steel, which contains 23 per cent. of nickel. The tub is naturally formed of several parts, insulated from each other, in order to avoid a closed metallic circuit through which only a portion of the current would pass. The refractory lining is made of either quartz in case of acid treatment or of dolomite and tar in case of a basic treatment. The core is formed of four branches, each composed of four bundles of sheet iron, separated from each other by a one inch air space for cooling purposes. Each bundle contains 105 pieces of sheet iron isolated from each other by a sheet of asbestos. The core weighs 12 tons. Its construction was a lengthy and delicate process, in view of all the precautions which had to be observed to avoid internal short circuits. The induction coil is composed of naked copper strips ⅛ inch thick by 3 15/16 inches long, assembled in twos to form a complete winding of 18 to 22 turns. An opening of 3/16 inch was left between each strip for the circulation of air for cooling purposes.

The Gassie's furnace avoids the use of circulating water for cooling, which is used in all other electric furnaces. Also the use of naked copper permits of easy variation in the number of turns in the coil. The simple alternating current of 16 cycles is provided by an inductor alternator of 400 kw., the load factor varying from 0.6 to 1. The excitation is provided by the power station at 250 v. The line which connects the alternator with the furnace measures some 60 feet. It is made of 12 copper cables of 0.19 inches cross section, spaced from each other in all directions by about 11.25 inches, the adjacent conductors being of opposite polarity. A room adjoining the furnace contains all regulating and measuring apparatus, amongst which has to be mentioned an integrating wattmeter, which enables us to read at any moment the power consumed and also the power used for each operation of the process. The pressure in the primary does not exceed 300 volts and the intensity varies from 1,200 to 1,400 amperes.

Some Interesting Particulars During Reduction Operations.—The furnace under review treats 1.2 tons of steel. The chemical analysis during treatment can be made with perfect ease as compared with the old combustion furnace. The whole process, which can be started at a moment's notice. lasts two or three hours, and the energy consumed varies from 300 to 500 kw. hours per ton according to the metal treated.

Efficiency of Electric Furnaces.—It is most important to ascertain the efficiency of the electric furnace as compared with the coal or coke combustion furnace and to find the relative cost of electrical and fuel heat. In order to do so, we must consider in one way or another the amount of heat each type of furnace will generate, and what amount of electric energy will be required to be transformed into heat to produce as much as, say, one pound of coal would yield when being burnt. It is well-known that one kilowatt hour is equal to 3,415 British thermal units, and if we admit that one pound of best Transvaal or Natal coal on burning will give 12,000 to 14,000 British thermal units, we find that one pound of coal will be equal in calorific value to about 4 kw. hours. The first comparison seems not in favor of electric power, as we have to pay over a half-penny per unit, but in localities where water power can be developed cheaply, and also where the cost for transport of coal is high, electric power will be at once cheaper than coal. But the above comparison is superficial, incomplete and misleading, if we neglect consideration of the utilization of the heat generated. It should be borne in mind that the utilization of heat differs in an electric from that in a combustion furnace. The largest part of the heat generated in an electric furnace is actually utilized in heating the materials in the furnace, whereas in the combustion furnace this is not the case, particularly in one which requires a high temperature, the greatest portion of the heat being simply wasted and but a very small part actually utilized.

Before going into details I shall explain what I understand by the *efficiency* of a heating apparatus, such as a furnace. The efficiency is the ratio of heat units actually utilized in heating the contents, to the total heat units supplied either in the form of coal or electricity. In this connection the following table, prepared by Prof. Richards, will be of great interest, as it shows the typical efficiencies of the different furnaces:—

Crucible steel furnace	2 to 3%
Reverberatory furnace	10 to 15%
Regenerative furnace	20 to 30%
Shaft furnace	30 to 50%
Electric furnace	60 to 85%

These figures apply both for melting or smelting. A few words of comment will explain the above-mentioned table. In the crucible and reverberatory furnaces the greater part of the heat is carried away in the hot escaping gases. In the shaft furnace the heat is largely absorbed by the solid materials, mostly in the upper portions of the furnace. The furnace gases which are produced in electric smelting are very much less in volume than in combustion furnaces. Another point to be considered is the amount of atmospheric air that passes through the combustion furnaces in excess of that actually required to burn the fuel, which increases the already great loss of heat; and lastly, there is a serious loss due to incomplete combustion of fuel. All shut-downs, which are mostly inevitable, tend to lessen the efficiency of combustion furnaces, but the same does not apply to electric furnaces, as the supply of electrical energy is simply cut off. Thus, comparing the relative costs of electric and fuel combustion from the point of efficiency or useful work done, the electric furnace proves to be cheaper.

Experiments have been made, and it was established by actual measurements, that a much larger proportion of the heat generated electrically is transferred to the furnace charge than it is possible in a combustion furnace, in which the carrier of heat consists of a larger volume of gas, and in spite of all regenerative (Siemens) methods for smelting work, the method of heat transference by the individual hot gas molecules to the metal baths is a faulty one indeed. In the electric furnace, however, the main portion of heat is generated in the space intervening between the electrode and the slag, which space is less than an inch in width. The bottom surface of the electrode is at the volatilization temperature of the carbon, and thus a considerable portion of heat passes to the smelting charge by radiation, by means of carbon vapor. The carbon vapor, which starts from the electrode, is impinging continually on the surface of the slag, and is consumed by the slag oxides. In this way both fused materials, metal and slab, themselves form additional producers of heat. They further serve as resistance in the path of the current, and the layer of slag converts a very large amount of electricity into heat. The distribution of heat in the electric furnace is a long way the more economical. A most energetic reaction takes place in the space between the overheated particles of the slag, the electrodes and the constituents of the metal bath, which is the reason of the immense success of the operation. The rapidity of the work is due to the high current density, the enormous heat production in a narrow space, and the very great rapidity of the chemical reactions. All this produces an energetic mechanical flow of the liquid particles in the slag and the metal, which has a most favorable influence upon the desired change of constitution.

There will probably be many sceptics as to whether the electric furnace will supplant the different combustion furnaces mainly for smelting now in use on the Rand, but to those I would point out that at the end of 1910, France had only one electric furnace, and hardly twelve months later the number grew to thirty-five. Electricity has won the day everywhere, in spite of conservative opposition, and ere long war will be declared on the old combustion furnace, and I would recommend everyone to be on the side of the electric furnace.

The development of the natural gas areas in New Brunswick is proving a boon to the Intercolonial Railways. In the shops at Moncton it is used exclusively for the generation of power. The steady and reliable heat makes it an ideal fuel for the blacksmiths' forges, furnaces and gas engines. Being immediately ready for use there is no time wasted in "firing-up." Over 30,000,000 cubic feet of gas were used in September, and in the winter months 50,000,000 feet per month will be necessary to meet the railway's requirements, and results show considerable saving in expenditure. It is not generally known that this gas is used for the lighting of the railway's passenger cars all over the line.

EXTINGUISHING OF FIRES IN OILS AND VOLATILE LIQUIDS.

A PAPER dealing with the difficult problem of extinguishing fires in oils and in volatile liquids, has been written by Edw. A. Barrier, of the Department of Inspection, Associated Factory Mutual Fire Insurance Companies, Boston, for the American Society of Mechanical Engineers, New York. In his article, Mr. Barrier says that our most common extinguishing agent, water, works rather unsatisfactorily, and frequently disastrously, where fires of this kind occur; but concedes that it is still the only one available where heroic measures are required. However, two or three other materials have been introduced as extinguishers which have given promising results, and Mr. Barrier's paper is devoted to a discussion of these materials and to the conditions under which they prove most efficient.

It is only fires in volatile liquids where these are not miscible with water, in which water is of little or no effect, save to wash the burning liquid out of the building, where it may be consumed completely, or, if the quantity of liquid is small, where it may be extinguished by the brute cooling effect of a large quantity of water sprayed upon the fire. Where the liquid (such as denatured alcohol, wood alcohol, grain alcohol, acetone, etc.) is miscible with water, water may, of course, be used effectively. For non-miscible liquids, soda and acid are somewhat more effective, though non-infallible, extinguishers. However, only two principles can be relied upon in the extinguishing of fires in volatile oils—e.g., either to form a blanket of gas or of some solid material over the burning liquid so as to exclude the oxygen of the air, or to dilute the burning liquid with a miscible and non-inflammable extinguishing agent.

Mr. Barrier proceeds by discussing sawdust and bicarbonate of soda as blanketing types of extinguishers.

Ordinary sawdust is an excellent extinguishing agent for certain volatile liquids, especially those of a viscous nature. In the fall of 1912, experiments were performed by the inspection department of the Associated Factory Mutual Fire Insurance Companies, and fires in lacquer and gasoline in tanks were extinguished with sawdust with results both surprising and satisfactory.

The liquids were placed in three tanks 30 in. long, 12 in. wide and 16 in. deep; 48 in. long, 14 in. wide and 16 in. deep; and 60 in. long, 30 in. wide and 16 in. deep. The sawdust was applied with a long-handled, light but substantially built snow shovel having a blade of considerable area. In every case the fires were extinguished readily, especially in the two smaller tanks which were about as large as any ordinarily employed for lacquer in manufacturing establishments.

The efficiency of sawdust is greater on viscous liquids than on thin liquids; because it floats more readily upon the former. The sawdust is not easily ignited; but, when ignited, both burns without flame, and does not generate sufficient heat to reignite the liquid. Again, the character of the sawdust, whether from soft or from hard wood, is not an important consideration; neither is the amount of moisture contained in it; and thus the drying out of the sawdust when kept in manufacturing establishments for a time, does not effect its efficiency. However, the experiments showed that the admixture of bicarbonate of soda increases greatly the efficiency of sawdust, both by shortening the time of extinguishing and by decreasing the amount of material necessary. A further advantage of the admixture is that it decreases the possible danger resulting from the presence of sawdust in manufacturing plants. It would be difficult, probably impossible, to ignite the mixture through any chance carelessness.

Though the efficiency of the sawdust is greatest on viscous liquids, such as lacquers, heavy oils, etc., it was tested very satisfactorily also upon ignited gasoline, both contained in the smallest tank and spread upon the ground. Tests of the mixture conducted in larger tanks upon ignited thin liquids were unsatisfactory; since the sawdust sinks before the whole surface can be covered, and the exposed liquid reignites.

Another agent to which attention has been devoted in recent years is carbon tetrachloride. It is non-inflammable, non-explosive, and readily miscible with oils, waxes, japan, etc. When mixed with inflammable liquids, it renders them non-inflammable, provided a sufficient quantity is added. The specific gravity of its vapor is about 5½ times that of air; consequently it settles very rapidly. As an extinguishing agent, it both acts as a blanqueting agent—covering the burning liquid with gas or vapor—and dilutes the inflammable liquid, rendering it non-inflammable.

The use of carbon tetrachloride as an extinguisher has been explored chiefly by certain manufacturers producing extinguishers which use liquids; but the claims made for these extinguishers are, for the most part, grossly exaggerated, declares Mr. Barrier. None of these is more efficient than carbon tetrachloride, and none is the equivalent of ordinary water extinguishers for general use on such materials as cotton, wool, paper, oily waste, etc. However, Mr. Barrier allows that, on volatile liquids, oils, etc., carbon tetrachloride has shown very satisfactory results under some conditions, and allowing for the skill of the operator and the nature of the fire. For example, in tank fires the length of time that the liquid has been burning is an important factor; for, where the sides of the tank have become heated, the only way in which the fire can be extinguished is to squirt the liquid forcibly at the sides. To squirt it directly into the liquid makes extinguishing much more difficult, if not impossible.

A second important consideration is the height of the liquid in the tank. Where the liquid is low, the sides form a pocket which retains the vapor and aids considerably in smothering the blaze. When the tank is nearly full, however, this condition does not exist, and it is then very difficult, if not impossible, to extinguish a fire in a highly volatile liquid, such as gasoline; and only the most skilled operators are successful in these cases. Further, the size of the tank or the extent of the fire if upon the floor is, as would be expected, of considerable importance. In tanks larger than about 28 in. by 12 in., more than one extinguisher and operator working at a time are necessary to extinguish a fire in such materials as gasoline. In one test where a tank 60 in. by 30 in. was used no less than seven operators were necessary, and even then it was only with the greatest difficulty that the fire was put out.

Mr. Barrier points out that his remarks apply to carbon tetrachloride as generally sold in the ordinary one-quart extinguishers, and proceeds to consider the probability of greater efficiency from a larger extinguisher. This, however, would have to be specially designed to make it readily portable by mounting on a truck or some similar means. The writer then discusses a few systems recently installed in which an elevated tank containing carbon tetrachloride was connected with automatic sprinklers or perforated pipes located in hazardous rooms where volatile and inflammable liquids are in use. So far as is known none of these systems has as yet been called upon to extinguish a fire, but there appears to be no reason why such a system should not provide excellent protection in special cases. In such systems it would be necessary to consider the safety of the workmen and furnish ready means of escape, since carbon tetrachloride is an anesthetic and where thoroughly sprayed through the air as from an automatic sprinkler it would probably produce rapid results.

The nature and effect of the fumes given off when carbon tetrachloride is thrown upon a fire is a subject which has received a great deal of discussion. When the liquid comes in contact with a fire the vapor is partly decomposed resulting in the evolution of a considerable quantity of black smoke which is undoubtedly finely divided carbon. Pungent gases are also produced which appear to be mostly hydrochloric acid with possibly a small amount of chlorine. Since carbon tetrachloride contains no hydrogen from which hydrochloric acid could be formed this substance must be produced by the action of chlorine on the gases arising from the burning material or upon the moisture of the air.

The fumes of carbon tetrachloride although of a very pungent nature do not produce any permanent injury under ordinary conditions where the operator can make his escape after he has inhaled all that he can stand, but they are a distinct handicap in fighting a fire and are one of the objectionable features to carbon tetrachloride as a general fire extinguishing agent. In large rooms or where a small quantity of carbon tetrachloride is sufficient to extinguish a fire the gases are of course less objectionable.

Mr. Barrier concludes his paper with the consideration of the method of extinguishing fires in oils and volatile liquids, recently proposed and experimented, e.g., the use of frothy mixtures. He considers the idea as a favorable one, the tests thus far reported having indicated satisfactory and promising results. The principle of this process the writer shows to be by causing two liquids to mix in a tank where foam is produced, by making the tank air-tight and then forcing the foam out by carbon dioxide under pressure and conveying it to the fire by means of a line of hose. However, no experiments have, as far as is known, been conducted in this country; and German scientists have not disclosed the exact nature of the liquids used. Yet, Mr. Barrier concluded with the statement that this method of extinguishing fires in oils and volatile liquids will undoubtedly prove to be by far the most efficient of any that has as yet been suggested.

NATIONAL ASSOCIATION OF PURCHASING AGENTS.

This new organization was formed in New York City on October 16th. Its membership will include purchasing agents and buyers representing some of the largest industrial corporations, railroads, steamship lines, street railways, gas and electric companies in New York, New Jersey, and Connecticut. The association has already a membership exceeding one hundred. H. T. Leeming, of Thos. A. Edison, Inc., is President, and E. B. Hendricks is Secretary-Treasurer.

The double-track electric railroad which is being built between Tokyo and Yokohama will be the most up-to-date in the Orient when finished early next year.

RAILWAYS AND MOTOR TRACTION.

THE following extracts from a paper by Mr. W. W. Hoy, general manager of South African Railways, read at the recent conference in London (Eng.) on motor traction, will be of interest in showing the possibilities of freight service to districts which, under ordinary conditions, would not have a railway line laid for many years.

In the course of his remarks, Mr. Hoy stated that the progress that has been made in constructing and perfecting road motor vehicles has been keenly followed by the South African Railway authorities, and the use of motor transport is regarded as a system especially suited to South African conditions, and should prove of great value for developing outlying districts sufficiently until the traffic offering justifies the construction of a line of railways, when the motor vehicles would be available for use in the development of other districts.

Attention was drawn to the fact that the South African railways are state-owned and motor services as feeders to the railways can be worked as branch services, the organization being as far as possible on railway lines.

Mr. Hoy pointed out how at one depot the postmaster controlled the motor staff and running details of service, whilst at others, duties were performed by the station master, thus ensuring economy.

As regards the most suitable type of vehicles, Mr. Hoy said, speaking generally, he was of opinion that for cross country freight traffic, powerful paraffin tractors with large and wide wheels would be most suitable. In most cases rubber-tired vehicles for heavy goods traffic could not be regarded as a practical proposition where transport had, in some cases, to be done at the rate of 4d. per ton per mile.

The average working costs for a paraffin tractor and trailers Mr. Hoy gave as follows:—

Average daily run (in miles), 15 to 30.

Average cost per car mile, including 20 per cent. depreciation, 4 per cent. interest, rent, insurance and supervision charges, 4s.

Cost per ton per mile, 5d.—3d. 15 to 30 miles.

Miles per gallon of fuel, 1.5 m. p.g.

Costing per car mile, 4s. 9d.

INCREASING PRODUCTION OF CEMENT.

According to the statistics contained in the report of Mr. J. McLeish on Economic Minerals and Mining Industries of Canada, the total production of cement in British Columbia in 1911 amounted to 401,000 bbls. valued at $601,500; in 1912 to 511,539 bbls., valued at $767,038; in Alberta for 1911 it amounted to 512,176 bbls. at a value of $1,241,535, for 1912 to 821,165 bbls., at a value of $1,775,898; in Ontario, for 1911, the production attained to 3,090,786 bbls., valued at $3,741,-039, for 1912 to 3,044,713 bbls., valued at $3,372,897; and in Quebec, for 1911 the outlay was 1,614,730 bbls., worth $1,-963,439, while for 1912 it was 2,714,685 bbls., worth $3,134,-499. In each province is shown an increase in both production and the value thereof.

Eight years of labor and the expenditure of nearly $30,-000,000 had their fruition on November 4th, when the water of the Los Angeles aqueduct, drawn from the high Sierras, 260 miles eastward, was turned into the big San Bernardino reservoir, 23 miles north of the city. Caravans of automobiles took crowds out to the reservoir, which was the scene of the initial features of a two days' celebration.

COAST TO COAST.

Regina, Sask.—The G.T.P. is operating another 100 miles of its new line through British Columbia.

Fredericton, N.B.—The Foundation Company, Limited, has completed its work on the Highway Bridge, and is shipping its plant to its next centre of labor.

Vancouver, B.C.—The matter of the formation of a water commission to take charge of the supply to Vancouver, as well as to the outlying municipalities, is being considered by Provincial Water Commissioner Young.

St. Thomas, Ont.—The three transformers for the new hydro-electric sub-station on the armory property, are being installed. This station is to supply several industries in the southern part of the city, and will relieve greatly the load on the main station.

Nelson, B.C.—Mr. W. P. Tierney, contractor for this portion of the C.P.R. Railway, announces that by December 15th the Kaslo and Slocan line, which is to provide railway connection between Kaslo, Slocan, the Arrow Lake and the coast, will be in operation.

Medicine Hat, Alta.—The new power plant was in operation the 23rd, 24th and 25th of October, and in the course of a few days will be put into permanent operation. In the Construction Department 2-10 K.W., 2-5 K.W., 2-2 K.W. transformers were installed.

Camrose, Alta.—While proceeding with drilling for natural gas at Camrose, the contractors have struck a 15-foot seam of coal. The coal is said to be of splendid quality, and was encountered at a depth of 400 feet. The contract for gas drilling calls for a depth of 1,500 feet.

Sault Ste. Marie, Ont.—Strenuous endeavor is being made to make sure the passing of the new drydock by-law. The $25,000 guarantee deposit has been placed in the Bank of Commerce. The people seem anxious to secure the new $10,000,000 industry, to which they will give a bonus of $20,000 per year for 20 years.

Edmonton, Alta.—On November 17th, 200 miles of new railway on the Canadian Northern Railway's western division were placed in operation. Of these 200 miles, 150 are in Alberta, and the remainder in Saskatchewan. These new stretches of railway provide new services between Alsask and Hanna, and between Drumweller and Hanna, in Alberta, and from McRorie to Elrose, Sask.

Ottawa, Ont.—Mr. J. D. McArthur, contractor for the Hudson Bay Railway from Le Pas to Port Nelson, stated while in the capital that over 159 of the 420 miles to be graded have been completed; and that before the season's operations cease, steel will have been laid on 130 miles of the grade. At the end of next season, Mr. McArthur hopes to have reached Port Nelson with the grade.

Port Arthur, Ont.—It is expected to complete the connection of the Sudbury-Port Arthur section of the C.N.R. before the end of December, and, if necessary, a freight service may be run over the line during the winter. The first passenger train will run some time during the summer of 1914. To lay the line from Ruel to Port Arthur, a distance of about 500 miles, will have taken approximately two and a half years.

Fort William, Ont.—The Mission River has been officially declared open for navigation. Captain McAllister, harbor-master, and W. P. Merrick, harbor engineer, performed the ceremony by placing the spar buoys marking the channel from the mouth of the river out into the deep lake water. The dredging of this channel was started early in the spring, and has resulted in a passage 600 feet wide, 25 feet deep, and extending over 1,400 feet.

Medicine Hat, Alta.—The report of the city health officer on the water supply, dated October 31st, declares that analysis of city water has shown it to be almost entirely pure. There are contained only small quantities of harmless salts and lime, aside from traces of silica, aluminum and oxide of iron. The colon bacillus (typhoid germ) was entirely absent, while the bacterial count was 118 per cubic centimeter, which is remarkably low.

Redcliff, Alta.—Mr. R. Wray, superintendent of the Gas and Light Company, has stated that within a few days the south end of the town will be connected with the new gas well on the river bank, and will be supplied with a uniform pressure equal to that enjoyed by the rest of the city. This year, moreover, the company expect to accomplish the laying of 26,340 additional feet, or five miles, of pipe, and the gas building is now practically ready for occupancy.

Medicine Hat, Alta.—Two new gas wells were completed during the month of October, one in the West Industrial Site and one in Harlow Fuller Subdivision, and up to date these wells are satisfactory, the Harlow Fuller well being an especially good one, the capacity being over 3,000,000 cubic feet for 24 hours and the rock pressure approximately 550 pounds per square inch. A well in Block 5, Cousins & Sissons' Subdivision, is under course of construction at the present time.

Galt, Ont.—It is expected in Galt that the C.P.R. double-tracked main line will have reached there before 1915. The track is already in operation between West Toronto and Erindale; and work is proceeding satisfactorily to Guelph Junction. Tracks have been laid, but the new roadbed has yet to be ballasted. The work, however, cannot be carried much further than Galt next season; for several natural difficulties, such as rock cuts and deep gullies, will force construction to progress much less rapidly. Considerable time will be required before the road has reached Woodstock and London.

Winnipeg, Man.—A special announcement to the Winnipeg "Weekly Beacon" from Mr. Collingwood Schreiber, the Dominion Government's chief engineer, says: "The golden spike of the Grand Trunk Pacific Railway will be driven near Fort Fraser, B.C., early next summer. By April the grading of the line will be completed." Less than 300 miles remain to complete the connection of the Transcontinental Railway. Either the Duke of Connaught or Premier Borden is to drive the final spike; and old No. 1 engine, of the G.T.R., still on duty as a shunter in the east, will pull the first through train over the new road from old Ontario to the Pacific Coast.

Ford, Ont.—This new city is distinguished by the fact that the foundation for a mammoth producer-gas engine has been finished here. The engine is to supply power for the Ford Motor Company plant in Detroit. The length of this latest creation in power plant engine building is 73 feet and its overall width is 32 feet. The crank shaft is 32 inches in diameter, 25 feet long, carrying an 80-ton fly-wheel and a 2,500 kw. generator; armature and the connecting rods weigh 10,300 pounds each. The generator is capable of carrying a 25 per cent. overload, and the engine has a capacity of 5,000 i.h.p. Work on this new power plant is being rushed as the capacity of the present generating apparatus is much over-taxed.

Victoria, B.C.—As a result of the settlement of the earth beneath the pavement on Oxford Street, between Linden and Moss Streets, the big brick sewer constructed along that street three years ago has caved in, the pavement above has collapsed, and damage which will require an expenditure of approximately $8,000 to repair, has been done. The street, when the roadway improvement was made, was graded up to the requisite level, and apparently this new earth, with the action of the water which has drained beneath the pavebase has settled the earth, the pressure on the sides of the brick sewer beneath causing the cave-in on that work. The lack of support beneath the pavement has allowed that part of the street work to settle.

Montreal, Que.—Mr. R. P. B. Motley, the chief engineer of bridges for the C.P.R., said, in reference to the Lachine bridge construction, that three years had been necessary for the work owing to the fact that the traffic over the bridge on the single track was not delayed for a moment throughout the entire time of erection. In reality there were two bridges, each of single track, and by well-considered methods the structure was erected in sections—traffic being shifted from up stream to down stream until the bridge was completed. The bridge is now open for double-track service, and will be of immense convenience and benefit in the operation of traffic in and out of the Montreal terminals. The Lachine bridge adds another to the many engineering triumphs the C.P.R. has realized since its inception—the necessities of the original survey, especially in the West, compelling the company to build almost countless bridges as it went along, which early gave the company a deep interest in efficient designing and bridge building.

Saskatoon, Sask.—Engineer Clark has reported to the city council concerning the flow of quicksand on Long Hill slide the following: "The driving of the steel sheet piling was completed on Saturday, October 25th, and during the following week excavation was being made through the quicksand layer down to clay for the purpose of placing boulders. This had been accomplished for about one-half the total length when towards the east end of the piling the layer of sand became thicker and apparently dipped into the face of the hill. The removal of part of the top dry soil which was necessary in order to determine the conditions existing, allowed the running sand to flow so freely that excavation was at once stopped and arrangements were made to drive sheet piling to prevent a further flow of sand until the excavation could be made. The seriousness of this situation is understood when it is explained that the sand was apparently flowing from underneath the end of the retaining wall. The work of driving the sheet piling is well under way. Mr. Clark, however, would not state positively that the driving of sheet piling will stop the flow permanently.

Vancouver, B.C.—The work on the new station in connection with the terminal improvement scheme for the C.P.R. is progressing favorably. It is expected that the east section of the new depot will be ready for occupancy by Feb. 1st. The new building will, when erected, be an imposing structure, with massive Corinthian columns adorning the facade, and with stone cornices and trimmings enhancing its general appearance. The building will extend almost two blocks along Cordova Street, from the middle of the block between Seymour and Richards to Granville Street. It will be of the most up-to-date and substantial construction, strongly reinforced with steel, with concrete floors and solid pillars. The retaining wall in front of the depot, built in order that the tracks may be raised five feet from the present level, is now nearly finished. A railing to separate the passenger tracks from the yards and freight lines will surmount the wall. The change in the grade will result in a greater elevation for the entire station layout, leaving the other tracks on the present level. The girders for the station shed, which will jut out from the main building, are now being placed in position.

Victoria, B.C.—The Provincial Government has expended this year the gigantic sum of $4,000,000 on road extension and improvement work, according to the recently issued statement of the Hon. Thomas Taylor, minister of public works. The present length of roads and trails in British Columbia is 18,000 miles; and the sum required for maintenance has increased, and will increase, rapidly, owing to the additional mileage, and to new conditions which have arisen during the past few years. Upon bridges, which are generally classified under the heading of road improvements, the sum of $900,000 has been expended by the provincial works department this year, with $50,000 for wharves, and $70,000 for road location work. On road machinery, of which the most up-to-date types have been secured, the expenditure was $100,000. The road construction of particular interest was, however, the Banff-Windermere road. When it is finished there will be in existence a fine, circular 500-mile auto highway running from Calgary through to Banff, across the boundary line to Castle Mountain, south to Sinclair, further south to Fort Steele, thence east through Southern Alberta, and north again to Calgary via the Alberta roads, parallel to the Calgary-Macleod Railway line. Every link in this great highway is now in use except between Castle Mountain and Sinclair, a distance of seventy-two miles, of which about thirty-five miles of roadwork has been completed, leaving less than forty to finish next year. It is generally believed that with a sufficient appropriation from the Legislature next year, and good working conditions, the highway link referred to will be finished before the end of 1914. Great progress has been made in connecting the different district trunk roads into one main road to traverse the province, over $100,000 being spent upon the Hope-Princeton connection, while through the Similkameen, Grand Fork*s*, Greenwood, Ymir, Fernie and Cranbrook districts, splendid progress has been made with standardization work.

Vancouver, B.C.—Mr. Sidney Billington has written an interesting sketch concerning the opening up of the Fort Fraser district and the linking up of the Transcontinental line between the east and the west, now rapidly nearing completion. The following is an abridged quotation: "Boundless farm, forest and mines in the northern interior of British Columbia will be thrown open to hundreds of thousands of settlers next year when the transcontinental line of the Grand Trunk Pacific Railroad will have direct communication between Prince Rupert, the western terminus, and the eastern maritime seaboard. The only remaining link to be completed is represented by a comparatively few miles in British Columbia, and there is every assurance that the contractors will complete their stupendous task before the end of the summer of 1914. With few exceptions, indeed, the grading is now completed and the worst of the canyons which disputed the progress of the bands of steel have been spanned. Mineralogists and agricultural experts are agreed that the section of British Columbia through which the line passes contains tremendous values which will amply repay those who undertake the development. Logical trade centres are being established along the route, and many of these will be invaluable to miner and agriculturist alike. A disputed point is, however, the possibility of too many townsites being instituted. With Fort Fraser, the situation is entirely different. It has no opposition. The town is growing up on absolutely fixed lines, and will draw on the largest stretch of agricultural country anywhere in British Columbia. Anything that will grow outside the tropics has been raised to perfection in the Fort Fraser district, and the average crops per acre are large enough to show highly satisfactory returns, giving handsome profits on the time and capital expended. And now, where a year ago stood a pre-emptor's hut, a town is daily growing into an active commercial centre. With an unlimited supply of water power for hydro-electric purposes, Fort Fraser will attract many large industrial concerns, which, being on the ground, will have the advantage over freight rates and be enabled to successfully compete with the manufacturers in east and south."

PERSONAL.

LEONARD W. RUNDLETT, city commissioner and city engineer of Moose Jaw, Sask., has tendered his resignation, to take effect January 1st, 1914.

FRANK B. GILBRETH, consulting engineer, New York City, addressed a large meeting of the Engineering Society on November 12th on one of the numerous phases of the subject of "Scientific Management."

GEORGE SERVICE, consulting engineer, of Toronto, has become associated with the Dominion Power and Transmission Company, Limited, Hamilton, taking charge of the construction of their new steam plant.

C. J. McLAUGHLIN, of the United States Department of Health, Washington, is working in conjunction with Dr. J. W. S. McCullough, Provincial Officer of Health for Ontario, in the preparation of an exhaustive report on the "Pollution of Boundary Waters" to be made to the International Waterways Commission in the course of a few days.

JOHN B. ARMSTRONG, for several years in charge, as chief engineer of construction, of the building of the Hudson Bay Railway, has tendered his resignation to the Government. He purposes engaging in contracting. It is stated that J. PORTER, who has been on the construction of the National Transcontinental Railway, will succeed him.

OBITUARY.

The late Mr. JAMES MELVILLE ROBERTSON, A.M.I.C.E. and A.M. Can. Soc. C.E., who was accidentally killed by the discharge of a rifle at Sylvan Lake, Alberta, on the 14th of September last, was the only son of Mr. and Mrs. James Robertson, of Bonneybridge, Stirlingshire, Scotland He was 27 years of age, and received his earlier education and training for the profession in Glasgow, Scotland, being a graduate of the Glasgow West of Scotland Technical College, and afterwards a pupil of Messrs. Wharrie & Colledge, Civil Engineers, Glasgow. His experience subsequently has been principally on Canadian railways. By his great zeal for his work and thoroughness in the execution of his duties, he rapidly gained the confidence of his employers, and at the time of his death held the position of resident engineer on the construction of an important part of the Alberta Central Railway, which included the building of the large bridge across the North Saskatchewan River at Rocky Mountain House, Alta. He was a young man of sterling character, with bright prospects for the future, and made for himself many professional associates.

THE AMERICAN INSTITUTE OF ARCHITECTS.

The 47th annual convention of the American Institute of Architects is to be held in New Orleans, La., on Dec. 2nd, 3rd and 4th.

1914 CONGRESS, AMERICAN HIGHWAY ASSOCIATION.

Knowing well the benefit of the impetus to good roads throughout surrounding territory which the American Road Congress affords the city in which it is held, some fifteen of the leading cities of the United States are vigorously contending for the 1914 Congress. While no decision has yet been reached, it is indicated that the contest is principally between Atlanta, Denver and New Orleans. It is stated that San Francisco, Spokane and Los Angeles are campaigning vigorously to secure the Congress for 1915. the year that the opening of the Panama Canal will be celebrated on the Pacific Coast.

THE DRIVING OF MOUNT ROYAL TUNNEL.

The Engineering Alumni Association of the University of Toronto held its first meeting for the season on Monday evening, November 17th. Mr. S. P. Brown, Managing Engineer, Montreal Tunnel and Terminal Company, addressed the meeting on the "Mount Royal Tunnel." His talk was well illustrated by numerous slides, descriptive of the engineering features of the work, and comparative of this great undertaking of the Canadian Northern with the Pennsylvania Tunnel and the New York East River Tunnel. About three hundred members of the Engineering Alumni Association were in attendance, while the Toronto Branch of the American Institute of Electrical Engineers were also present to the extent of about twenty members.

CANADIAN SOCIETY OF CIVIL ENGINEERS, VICTORIA BRANCH.

On Nov. 13th, the Victoria Branch was addressed by Mr. H. A. Icke, who spoke upon "Some Disregarded Stresses in Reinforced Concrete Design." The next assembly is the annual meeting on Dec. 11th, when Mr. F. C. Gamble will give an address, entitled "Some Engineering Works in British Columbia." The annual election of officers will also take place at this December meeting.

ANNIVERSARY DINNER.

The University of Toronto, Engineering Society, announce the date of their Annual Dinner as Friday evening, December 5th. The event is being held in honor of Dean Galbraith, this being the fiftieth anniversary of his entrance to the University of Toronto as a student, and the thirty-fifth anniversary of the founding of the School of Practical Science, which, seven years ago, became associated with the University of Toronto as the Faculty of Applied Science and Engineering.

COMING MEETINGS.

AMERICAN INSTITUTE OF ARCHITECTS.—Forty-seventh Annual Convention, to be held in New Orleans, La., December 2nd, 3rd and 4th.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.—Annual Meeting will be held in New York, December 2nd to 5th. Secretary, W. H. Reed, 154 Nassau Street, New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The Annual Meeting will be held in New York, December 2nd to 5th, 1913.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.—Annual Meeting to be held in New York, December 10th to 13th. Secretary, C. D. Odsen, Polytechnic Institute, Brooklyn, N.Y.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.—Seventh Annual Convention will be held at Great Northern Hotel, Chicago, December 29th to 31st. Secretary, I. W. Dickerson, Urbana, Ill.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

20758—November 7—Approving location Glengarry and Stormont Ry. Co.'s line from mileage 0 to 24.05.

20759—November 6—Relieving C.P.R. from providing further protection at crossing of Godfrey Avenue, Winnipeg, Man.

20760—October 30—Refusing application of S. J. Blair, Calgary, Alta., for an Order staying proceedings under Order No. 19075, dated April 16th, 1913, and for permission to re-open matter of application of C.P.R. for authority to construct branch line for Northern Electric and Manufacturing Co., Limited, Calgary; but that Order authorizing construction of said spur be not construed as giving effect to said consent as will any way prejudice Applicant from hereafter claiming that Ry. Co. cannot construct said spur over land of Applicant without first taking expropriation proceedings under provisions of Railway Act.

20761—October 30—Granting application city of Calgary, Alta., for an Order directing C.P.R. to provide suitable level crossing where Calgary and Edmonton Ry. intersects 32nd Avenue: crossing to be constructed in accordance with Standard Regulations, and at expense of city.

20762—November 5—Granting application Rural Mun. of Fort Garry, Man., for an Order directing C.N.R. to provide proper culvert under its tracks where same cross Waller Avenue; culvert to be constructed at expense of said Rural Mun. of Fort Garry.

20763—November 5—Granting application Rural Mun., Fort Garry, Man., for an Order directing C.N.R. to provide crossing over said Ry., at Southwood Avenue, said municipality, at expense of municipality.

20764—November 4—Amending Order No. 20018, dated August 14th, 1913, by providing that cost of maintenance of watchman employed at crossing of Anderson Street, town of Grenfell, Sask., be apportioned as follows:—60 per cent. by C.P.R. and 40 per cent. by municipality of town of Grenfell.

20765—October 31—Directing that C.N.R. file with Board within ten days from date of this Order, plan in triplicate of a freight shed 30 x 40 ft., to be erected at St. Albert, Alta., Ry. Co. erect same within 30 days after approval of said plans.

20766—November 5—Granting application of Rural Mun. of Fort Garry, Man., for an Order directing C.N.R. to provide crossing over its tracks at Chevrier Boulevard, at expense of said municipality of Fort Garry.

20767—November 5—Granting application Rural Mun., Fort Garry, for an Order directing C.N.R. to provide crossing at Waller Avenue, at expense of said municipality of Fort Garry, Man.

20768—November 1—Dismissing application city Saskatoon, Sask., for an Order for leave to construct highway across C.P.R., at Avenue J, said city, by carrying Avenue J across at rail level.

20769—November 1—Granting application city of Saskatoon, for an Order to construct highway across C.P.R., at rail level, at Avenue I, said city, at its own expense.

20770—October 31—Finding and adjudging that title of Ry. Co. (Calgary and Edmonton Ry.), is sufficient and effective as against municipality of city of Edmonton, Alta., and should Peace Avenue be opened up, such opening would be subject to seniority of Ry. Co.'s title and construction.

20771—October 31—Finding and adjudging that title of Calgary and Edmonton Ry. Co., is sufficient and effective as against Mun. city of Edmonton, Alta., and that should Athabasca Avenue be opened, such opening would be subject to seniority of Ry. Co.'s title and construction.

20772—November 7—Rescinding Order No. 20624, dated October 22, 1913.

20773—November 8—Extending, until January 15th, 1914, time within which C.P.R. install bell at crossing of Port Burwell Road, at mileage 32.7 Port Burwell Branch.

20774—November 7—Authorizing C.P.R. to construct spur for loading ties from a point on southerly limit of right of way on its main line, White River Subdivision, Lake Superior Division, at mileage 44.32 from Chapleau, Tp. 43, Dist. Algoma, Ont.

20775—November 6—Authorizing C.P.R. to construct spur for Frontenac Floor and Wall Tile Co., Limited, Kingston, Ont., from a point on northerly limit of right of way, at mileage 101.58, Ont. Division, Kingston Subdivision, in Lot No. 8, Con. West of Great Cataraqua River, Tp. Kingston, Co. Frontenac, Ont.

20776—November 8—Authorizing C.P.R. to construct Lacombe Easterly Branch of Calgary and Edmonton Ry. Co., across thirty-nine (39) highways, mileage 180.61 to 221.11.

20777—November 8—Approving location C.P.R. station in Lot 16, Con. 5, Tp. Tay, Co. Simcoe, Ont., at Port McNicoll, at mileage 88.32 on Port McNicoll Subdivision, Ont. Division.

20778—November 10—Rescinding Order No. 20638, dated October 22nd, 1913.

20779—November 10—Authorizing C.P.R. to open for traffic portion of Lacombe Easterly Branch from Consort, at mileage 139, to Monitor, at mileage 149.

20780—November 8—Directing that, on or before June 1st, 1914, the C.P.R. install improved type of automatic illuminated electric bell at crossing of public road east of Mountain Grove Station, Ont., at mileage 44.65 on Havelock Subdivision, and thereafter maintain bell at its own expense; 20 per cent. of cost of installing be paid out of "The Railway Grade Crossing Fund," remainder by Ry. Co.

20781—November 10—Authorizing C.P.R. to open for traffic Lacombe Easterly Branch from Coronation to Consort, Alta., a distance of 32 miles: Provided that, pending completion of diversions, speed of eastbound trains approaching crossings at mileages 132.6 and 136.3 be reduced to 10 miles an hour, and bells be rung continuously between whistling posts and crossings. 2. Rescinding Order No. 17852, dated October 25th, 1912.

20782—November 8—Approving plan showing Logan Drain where it crosses G.T.R. in village of Blyth, Ont.

20783—November 7—Authorizing G.T.R. to construct and maintain, at its own expense, Bridge No. 62, mileage 152.25 from Black Rock, carrying 20th District of its Ry., over public road between Lot 12, Huron Road Con. and Lot 83, Maitland Con. Tp. Goderich, Co. Huron, Ontario.

20784—November 10—Approving location C.N.O.R. Parry Sound-North Bay line through Tps. Gurd, Nipissing, Himsworth and Ferris, Districts Parry Sound and Nipissing, Ont., from mileage 209.52 to 233.90, from Toronto.

20785—November 11—Approving revised location C.P.R. from mileage 5.08 to 7.16 and from mileage 9.68 to 11.51, Schreiber Subdivision, Lake Superior Division.

20786—November 11—Authorizing G.T.R. to construct siding into premises of Andrew Malcolm Furniture Co., Limited, town of Listowel, Co. Perth, Ont.; and to change location of existing track south of the proposed siding.

20787—November 10—Approving location C.N.O.R. Parry Sound-North Bay line through Tps. Burpee, Burton, Mackenzie, Ferrie and Mills, District Parry Sound, Ont., mileage 170 to 190 from Toronto.

20788—November 10—Approving location C.N.O.R. Parry Sound-North Bay line through Tps. Patterson, Pringle and Mills, District Parry Sound, mileage 190 to 209.52 from Toronto.

20789—November 11—Authorizing Esquimalt and Nanaimo Ry. to construct spur at Cowichan Lake, B.C., across roadway to station at that point.

20790—November 10—Directing that C.P.R. reconstruct culvert on its Chalk River Subdivision, Eastern Division, Bridge No. 53.2 near Arnprior, Ont.: work to be completed by January 1st, 1914.

20791—November 11—Relieving C.P.R. from providing further protection at crossing of public road at Cluny, Alta., at mileage 116.2 on Calgary Subdivision.

General Order No. 113—November 5—Adopting and confirming conditions and specifications set forth in Schedule hereunto annexed, under heading "Rules for Wires Crossing Railways," as conditions and specifications applicable to erection, placing or maintaining or electric lines, wires, or cables across all Rys., subject to jurisdiction of Board: Part 1 being applicable where line is carried over railway; part 2 being applicable where line is carried under Ry. 2. Any Order of Board granting leave to erect, etc., wires, lines, etc., across railway and referring to "Rules for Wires Crossing Rys.," be deemed as intended to be a reference to conditions and specifications set out in that part of said Schedule which is applicable to mode of crossing authorized. 3. Every Order granting leave to erect wires across any Ry., unless otherwise expressed, be deemed an Order for leave to erect same under and according to conditions, etc., set out in schedule applicable thereto. 4. Rescinding Order No. 8392, dated October 7th, 1909, approving "The Standard Conditions and Specifications for Wire Crossings," and conditions and specifications adopted thereby.

20792—November 11—Recommending to the Governor in Council for approval, Rules and Regulations of T.H. and B. Ry. (private instructions to train conductors).

20793—November 12—Authorizing City of Edmonton, Alta., to construct its Electric Street Ry. across G.T.P. Ry. at intersection of Twenty-Seventh Street, between Armstrong Avenue, and Cochrane Avenue, subject to certain conditions. Cost of providing half-interlocking plant be borne one-half by city and one-half by G.T.P. Ry.

20794—November 12—Directing that, within six weeks from date of this Order, G.N. Ry., fence its right of way on property of H. E. Knight of Grand Forks, B.C.; Ry. Co. to be liable to a penalty of $25 a day for every day it shall be in default of complying with provisions of this Order.

20795—November 12—Authorizing, subject to condition that traffic on highway is not obstructed, G.T.R. to reconstruct bridge carrying Durham Road between Con. 1 North and Con. 1 South, through Lot 72, Tp. Brant, Co. Bruce, Ont., over 22nd District, Middle Division of its railway, at Mile Post 125.25, near Hanover.

20796—November 11—Approving plan and specifications of drain, known as "Teillier Award Drain," to be constructed under G.T.R. in Lot 2, Lake Shore Con., Tp. Rochester, Ont.

20797—November 12—Directing that within 90 days from date of this Order, C.P.R. install improved type of automatic electric bell at crossing of first public highway east of Britannia, Tp. Nepean, Co. Carleton, Ont., at mileage 3.9 on Chalk River Subdivision, and thereafter maintain same at its own expense: 20 per cent. of cost of installation be paid out of "The Railway Grade Crossing Fund," and remainder by Railway Company.

20798—November 12—Amending Order No. 19430, dated May 19th, 1913, to provide that floor of subway be constructed of 6-inch concrete slab to extend full length of subway, one-half of cost be paid my Mun. Surrey, B.C., and one-half by Great Northern Ry.

20799—November 13—Approving location Alberta Central Ry. Co.'s Sounding Creek-Moose Jaw line from a point in Sec. 24-27-26, W. 3 M., to a point in Sec. 24-25-18, W. 3 M., being from mileage 220 east of Red Deer, to mileage 277.75 east of Red Deer, Sask. 2. Authorizing construction of said line across fifty-six (56) highways, mileage 220 to mileage 277.75.

20800—November 13—Authorizing C.P.R. to construct, subject to terms of agreement, spur into premises of Dominion Wire Rope Co., Limited, in Lot Cadastral No. 922, city and parish of Lachine, Co. Jacques-Cartier, Que.

20801—November 13—Authorizing, subject to terms and conditions contained in resolution of town of Lasalle, C.P.R. to construct spur for Montreal Light, Heat and Power Co., across St. Patrick St., and Lot Cadastral No. 1021, Parish of Lachine, Que.

20802—November 13—Authorizing C.P.R. to operate spur for Massey-Harris Co., Limited, from a point on existing spur in lane in Block 68, city of Medicine Hat, Alta., into premises of Massey-Harris Co., Lots 35 to 38.

20803—November 11—Authorizing C.N.R to construct across and divert public road between Secs. 24 and 23, Tp. 26, R. 23, W. 3 M., Alsask Southeasterly Line, Sask. Company, at its own expense, install and maintain improved type of automatic electric bell at said crossing.

20804—November 13—Authorizing, subject to an inspection by Department of Public Works for British Columbia after road is graded and gravelled its full length, V. V. & E. Ry. & Nav. Co., by means of an over-crossing, to construct across and divert Nicola-Princeton Highway, Lot 1775, Group 1, Yale Dist.

20805—November 1—Dismissing complaint and application of Edward A. Purcell, Saskatoon, Sask., alleging G.T.R. Ry. discriminates against his bus line in favor of Dunning Bus Line at Saskatoon.

20806—November 13—Refusing application of Rural Mun. of Fort Garry, Man., for Order directing C.N.R. to construct suitable crossing over its tracks across Fairfield Ave.

20807—November 13—Authorizing Director of Surveys for Alberta, to construct a diversion of road allowance in S.W. ¼ Sec. 32-18-14, W. 4 M., Alta., across C.P.R.

20808—November 13—Authorizing C.N.R. to divert Rue La Verandrye, city of St. Boniface, Man.; and take for purpose of such diversion, parts of Lots 572 and 574, D. G. S. 70 Plan 224 of said city, property of C. A. Gareau, subject to condition that company construct, as soon as new station is erected, a good 30-foot road alongside its right-of-way, from Rue La Verandrye to Rue Notre Dame, and grade said road properly leaving it in as good condition as Rue La Verandrye between Rue St. Jean Baptiste and crossing over tracks of Ry. Co.

20809—November 13—Authorizing C.N.O.R. to construct across and divert public road on Lot 38, Con. 18, Tp. Ferris, Stations 981 to 991. And rescinding Order No. 20060, Aug. 13th, 1913.

20810—November 13—Authorizing C.P.R. to construct, by means of grade crossing, its siding extension across public road at Worthington, Ont. 2. Authorizing, subject to terms of resolution, Ry. Co., to construct said sidings for Mond Nickel Co., Limited, Coniston, Ont., from a point on northerly limit of right-of-way, at Worthington, across public road and lands adjoining, in Lot 2, Con. 2, Tp. Drury, Dist Sudbury.

20811—November 13—Authorizing C.P.R. to construct extension to existing siding for Dominion Radiator Company, Toronto, Ont.

20812—November 13—Directing Municipality of North Cowichan, B.C., to move crossing of highway at mile-post 41—6½ feet from its present location to a point 1,350 feet south of mile-post 41. And rescinding Order No. 6642, February 27th, 1909.

20813—November 13—Amending Order No. 19506, dated June 7th, 1913, by substituting plan marked "A," dated September 2nd, 1913, for plan dated March 24th, 1913, approved by said Order.